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10 By: ROBERT S. GARNERO, J. VICTOR ROWNEY JAMES KETCHEL

Prepared for:

NAVAL ANALYSIS PROGRAMS (Code 431)
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OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
ARLINGTON, VIRGINIA 22217

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This report describes research into the improvement and assessment of an innovative decision aid known as the Strike Outcome Calculator (SOC). The SOC is a computerized decision tool for use by task force commanders in estimating outcomes associated with naval air strike courses of action. The present research refined and evaluated the SOC, implementing changes necessary to enhance its usability and acceptability in the fleet environment. As such, the research can be viewed as an evolution from concept to prototype of the decision aid. An experimental evaluation plan is submitted.

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CONTENTS

APPENDICES

ILLUSTRATIONS

TABLES

I INTRODUCTION

A. Background

The Office of Naval Research (ONR) is presently pursuing a five year multicontractor program to promote the development of decision aids and procedures in support of Fleet operations. The essential objective of the work is to improve tactical decision-making by blending a number of technologies such as decision-analysis, computer-driven graphic displays, advanced data-management systems, information feedback, mathematical prediction, tactical models, and organizational analysis into a practical system for shipboard use. Concentrating on the task force commander (TFC) and his staff, the project emphasizes decision aids that are designed to take advantage of the experienced judgments of senior officers in the operational situation, rather than relying on the predictions of system designers. In the operational situation these aids will provide guidelines and tools for the structuring of decision problems, eliciting judgments of probabilities and outcome preferences, furnishing stored data and models as requested by the decision maker, making statistical inferences, and displaying the implications of trial tactics prior to their execution. All of these objectives are compatible with ongoing command-control hardware programs. Decision makers will be provided with a man/computer interactive capability to help them examine and evaluate alternative courses of action.

B. Research Objectives

The Naval Warfare Research Center (NWRC) of SRI International (formerly Stanford Research Institute) has been a continuing participant in the above program under Contract N00014-75-C-0742. The present research has addressed the improvement and assessment of an SRI-developed decision aid known as the Strike Outcome Calculator (SOC). The SOC is a computerized decision tool for use by task force commanders in estimating outcomes

associated with naval air strike courses of action. The SOC consists of a computational algorithm, a medium (CRT terminal) for communicating inputs and outputs, and the required interface with the user. The concept and origin of the SOC are documented in NWRC-TR-14, "Augmentation of the Naval Task Force Decision-Aiding System: The Outcome Calculator."[1] The present research refined and evaluated the SOC, implementing changes necessary to enhance its usability and acceptability in the Fleet environment. As such, the research can be viewed as an evolution from the concept to the prototype of the decision aid.

As a necessary precursor to evaluating and assessing the SOC, a formal experimental evaluation plan was developed. Modest pilot studies were conducted to obtain data on the SOC, and also on the experimental vehicles themselves.

C. Conclusions and Recommendations

The conclusions and recommendations that emerged from the research are listed below.

1. Conclusions

(1) A key finding of the effort is the comparative advantage of the SOC over the manual approach. Besides the time advantage accrued by the SOC in initially structuring problems, the great advantage of the SOC is its very easy procedure for making a change in the plan, or testing a contingency course of action. Even a complicated change in the strike plan may only take 15 or 20 minutes on the SOC, whereas the manual calculations may have to be completely redone. It is this interactive ability of the SOC to quickly test various courses of action that makes it a very promising decision aid.

(2) The SOC capability to indicate outcomes of air tasks (excluding ASW) may be used for the majority of strike objectives of an attack carrier striking force required

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[1] J. V. Rowney, R. S. Garnero, and J. C. Bobick, Augmentation of the Naval Task Force Decision-Aiding System: The Outcome Calculator, Technical Report NWRC-TR-14, Contract N00014-75-C-0742, Stanford Research Institute, Menlo Park, California (April 1977).

in carrying out the Navy war missions of sea control and projection of power ashore.

(3) The SOC translates the broad level of detail used by the TFC into sets of parameters and values in a flexible and effective manner, producing consistent and credible results. Thus, the SOC can assist the TFC and his staff in producing better operational plans.

(4) The SOC experimentation booklets can aid researchers in obtaining Fleet user data on the utility of, and needed improvements for, the SOC.

(5) There are inherent limitations to the SOC internal computational algorithm. They include:

- The use of linear attrition and effectiveness.
- A general specification of the weather criteria.
- A general treatment of support aircraft.
- The classification of an aircraft as being either defensive or offensive, but not both.

2. Recommendations

(1) The SOC should be exposed to Navy operational planners by use of the experimental vehicles developed during the research. This would allow Naval users to aid in enhancing the SOC and additionally expose Navy planners to advanced techniques of which they are not now aware.

(2) SOC experimentation should be integrated into automated command and control system testbeds such as the ACCAT in San Diego and the ODA program in Philadelphia. Additionally, functional commands like the all-weather attack community at Whidbey Island, Washington, should prove to be invaluable in providing experimental results.

(3) Outcome calculator concepts for other warfare areas should be investigated, most notably ASW.

D. Report Organization

The report is organized in much the same sequence SRI followed in accomplishing its research. Upon completion of previously defined computer improvements, SRI developed an experimental plan to elicit and record command reaction to the use of the SOC as a decision aid. To this end, experimental booklets and an experimental procedure were developed, and are discussed in Section II-A. The procedure was never

fully implemented, but results were generated on a less structured basis and are discussed in Section II-B, describing pilot study results.

During the research, much effort was expended in verifying the validity of the SOC as an outcome calculator, aside from its other considerations as a component of a larger decision aiding system. Thus, sensitivity analyses were carried out on the SOC computational algorithm itself and questions were posed to it to try and ascertain its breadth as a naval strike planning decision aid. To this end, a strike planning problem was formulated and examined both with manual and SOC augmentation techniques. These results are found in Section II-C, while more specific sensitivity analysis and validation results are presented in Section III.

In conjunction with this document, SRI has published NWRC-TR-15, "The Strike Outcome Calculator (SOC), Description and Operating Instructions."[2] That document describes the detailed aspects of the SOC and instructs potential decision makers in its use.

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[2] R. S. Garnero, J. C. Bobick, and D. Ayers, The Strike Outcome Calculator (SOC), Description and Operating Instructions, Technical Report NWRC-TR-15, Contract N00014-75-C-0742, SRI International, Menlo Park, California (September 1978).

II SOC EXPERIMENTATION

The principal objective of the SOC project was to develop a computer-based method for helping TFCs and their staffs in the planning of air strikes. The SOC is useful both as a stand-alone aid and as a component within the TFC's decision aiding system. Its main purpose is to provide a method for predicting the outcome of various alternative courses of action involving the allocation of air strike resources.

Pursuant to the above objective SRI developed a prototype SOC that was demonstrated by SRI at the University of Pennsylvania, and was available for demonstration at other locations by using a portable terminal and telephone modem. Initial demonstrations of the prototype were judged sufficiently successful to warrant additional development and testing. *This was being done when the project was terminated.*

A. Formal Experimental Plan

The plan for further development of the SOC required an assessment of the effectiveness of the prototype and a determination of where improvements were most advisable. Assessing effectiveness requires gathering both objective and subjective performance data, and determining the sensitivity of the prototype for predicting outcomes from varied levels and types of inputs. Assessing improvements required that SRI systematically gather subjective responses from initial hands-on users as well as from those who witnessed demonstrations.

The first procedural step in executing the assessment plan was to compare performance using the SOC with performance using current planning methods. It was hypothesized that the SOC would greatly improve a planner's ability to predict the outcomes of various courses of action over present methods. To make this comparison it was necessary to determine current Fleet practices and variability in predicting the outcomes of air strikes. This variability might range from highly efficient

methods to virtually none. Observe that predicting the outcomes of air strikes tends to become increasingly necessary when there is air parity. Air superiority, on the other hand, tends to diminish recognition of the need, even though the need still exists.

To meet the stated objective SRI prepared three experimental booklets, which are described below. They are contained in Appendices A through C.

1. Introduction to the SOC Booklet

To compare performance SRI developed a common frame of reference for all subjects. This consists of a background statement, operational scenario, and problem statement, all of which are contained in the "Introduction to the Strike Outcome Calculator." This booklet was presented to cognizant personnel: (1) to acquaint them with the decision aids program, (2) to introduce the SOC, and (3) to provide an example of the type of scenario and air strike planning problem suitable for the SOC.

2. SOC Problem Definition Booklet

In order to collect data for assessing the effectiveness of the SOC, a second booklet was required. SRI developed the "Strike Outcome Calculator Problem Definition" to supplement the problem statement presented in the introductory booklet. The second booklet sets forth a more detailed concept of operations and defines a specific problem to be analyzed by participating naval officers. It also provides a questionnaire section designed to systematically assess the time required to complete analytical steps, the difficulty experienced at each step, and the methods used.

It was considered important to informally pretest the problem definition booklet to determine its suitability for broader applications. The concern was that methods used to predict the outcome of air strikes might vary so widely that some respondents would be poorly prepared to answer the types of questions posed in the booklet. The initial questionnaire was structured to the degree deemed necessary to ensure that the principal issues were addressed.

Pretesting was to proceed bv asking knowledgeable subjects to work the problem by using methods familiar to them. If they found the exercise to be of value and the questionnaire intelligible and appropriate, a broader application was planned. Their responses were to provide an initial indication of the state of training in air strike outcome planning. Responses were to be compared with those obtained using the SOC. If pretests indicated ambiguity about the meaning of questions, the presentation of the problem statement, or the relevance of the exercise, the materials were to be appropriately changed.

At the extreme, pretesting might indicate that too little air strike outcome planning is done to warrant a detailed comparative analysis. If it did so indicate, the objective comparison of SOC and non-SOC planning would be wholly quantified by demonstrating the facility with which knowledgeable SRI researchers use the system.

3. SOC Evaluation Questionnaire Booklet

After addressing the question of SOC effectiveness, emphasis was to be placed on improving the development of the prototype system. This too required a questionnaire. SRI designed the "Strike Outcome Calculator Evaluation Questionnaire" for those who had witnessed a demonstration of the system. The questionnaire in the third booklet is to be used in conjunction with the background materials, scenario, and problem statement set forth in the first booklet. For those not having access to these materials, the demonstration would have been expanded accordingly. Respondents need not have seen the problem definition booklet to answer the post-demonstration questionnaire. However, having attempted to solve the problem in that booklet would unquestionably have underscored the utility of the SOC in the subsequent demonstration.

The purpose of the evaluation questionnaire was to gather subjective data about the content, format, and procedures used in the prototype SOC. It has both structured and open-ended questions designed to cover the principal issues, to stimulate thinking, and to provide a means for gathering open responses.

Since it is entirely possible that the SOC concept might be found useful in areas other than air strike planning, one section of the evaluative questionnaire asked respondents to consider other areas of application.

Answers to the evaluative questionnaire and the information to have been gathered in response to the problem defined in the problem definition booklet would have provided both objective and subjective information with which to assess SOC utility. The materials to be used were designed for comprehensive and complementary coverage of the subject area. The approach was flexible enough to address the questions of SOC effectiveness and the further development of the SOC as separate but related issues.

4. Experimental Procedure

The above three experimental tools were to be used in conjunction with a procedure to be utilized in the Fleet. This procedure applied to naval respondents who were destined to participate in a formal demonstration of the SOC. The SOC materials were to be pretested and revised prior to the Fleet procedure execution in order to ensure their suitability for subsequent data collection.

After pretesting and revision of SOC materials, the sequence of steps to be taken was as follows:

(1) Identify and establish contact with naval personnel destined to participate in the demonstration.

(2) Send materials to proposed respondents. This will include a cover letter, the introduction to the SOC, and the problem definition.

(3) Request completion of problem definition within one week of receipt. Where feasible, a debriefing with key respondents is advisable. Otherwise, respondents are to mail problem definition to SRI.

(4) Review responses to problem definition prior to SOC demonstration.

(5) At demonstration meeting discuss responses, conduct demonstration, and answer questions about the SOC.

(6) After demonstration administer the evaluation questionnaire. Answer questions as requested.

(7) Collect and review responses to questionnaires; follow-up as necessary.

(8) Refine data collection procedures, materials, and demonstration for subsequent administrations.

B. Pilot Study Results

1. Background

As explained above, a demonstration and indoctrination of the SOC and its concepts among Fleet users was a part of the original research objectives of this project. After the project was commenced, however, the Fleet demonstration portion was abandoned in favor of conducting more controlled pilot studies with identified naval officers at SRI. To this end, SRI established a pilot study procedure.

These evaluation procedures of the SOC were limited to a one-day briefing, demonstration, and questionnaire evaluation, with the exception that the first two SOC booklets were studied by the subjects before the one-day session began. This procedure allowed the subject to become familiar with the general ODA project, its background, the problem scenario, the planning guidance, the concept of operations, and the strike plan problem definition. All of these items are presented in the first two SOC booklets. With this indoctrination to the problem the subsequent SOC briefing and demonstration was scheduled for 2 hours, leaving 4 hours for evaluations and suggestions from the subject.

Two naval officers participated in the described procedure. The first was a staff member from the Naval Air Station at Lemoore, California. He was experienced in strike planning operations, had considerable operational experience, and was familiar with computer terminal operations from his previous duty at SAC, Omaha. The second officer was a staff member at ONR, familiar with the ODA program.

2. Findings

Aside from the formal participation indicated above, SRI has been able to gather much subjective and qualitative data on the SOC from other sources. These include responses from attendees at an SOC demonstration in Philadelphia during September of 1977, and responses from retired Naval officers that were solicited by SRI. The findings in this section will summarize all of these input sources, except for those findings pertaining to the SRI experimental documents, which were examined only by the two previously mentioned naval officers.

Both pilot study subjects found the first two experimental booklets to be clear and concise. The scenario and problem description were aptly put forward and no questions were generated. The more familiar ONR respondent stated he had examined the first two booklets in 1/4 hour, while the other respondent indicated 2-1/2 hours of study was required. In neither case did the respondent attempt to work the stated problem within the context of his previous naval experience. This was done because the computational tasks appeared formidable, requiring many hours of work. More importantly, however, the problem was probably not attempted because this kind of planning was not a familiar experience to the respondents. Computation of losses and sortie rates for extended periods of time (days) appeared relatively foreign to the subjects. It was suggested that perhaps the two booklets should be combined. The third experimental booklet was found by SRI staff to adequately capture respondent suggestions and attitudes concerning the SOC.

SOC indoctrination briefs have continually run about one hour. Participants in these briefs have consistently been able to assimilate the information and concepts quickly and with no objections, and move quickly into active interaction and participation. It is felt that a naval officer could be thoroughly trained to use the SOC in about one week at a specialized Navy school, such as the TAO school in San Diego. One respondent was able to move from the "strike" course of action presented to him to an alternative "blockade" course of action. With help from SRI analysts, the respondent was able to translate his operational

plan into SOC formatted inputs with about 1-1/2 hours of analysis. He was able to understand "real world--model abstraction" links and the input table relationships.

Perhaps the most important finding concerning the SOC is that nothing comparable to it is being used presently in strike planning. Such present staff planning is done from experience, using a variety of thumb rules and charts. Very often the planning results in "sending all the available assets" instead of sending the force necessary to accomplish the objective. Many naval planners do not think in terms of asset attrition or how many effective sorties are required to accomplish a task.

The general consensus would indicate that the SOC could provide a useful tool for naval military planning in testing alternative courses of action and estimating outcomes under varying threat conditions. It could help establish a balanced allocation of forces within the limited fleet assets.

During the repeated SOC demonstrations, many suggestions were obtained relative to improving the SOC program itself and its associated interaction with the user. Many of these improvements were installed in the decision aid. The improvements centered upon:

- A new output summary table showing source of aircraft loss by day.
- A listing of daily sortie expenditure by aircraft type.
- The installation of a title and length of battle indicator for all output tables.
- A change in the character used to outline/draw the tables.
- The incorporation of table title cues when a choice of table number is requested.

C. Breadth and Adaptation of SOC

The strike objectives for an attack carrier strike force, as listed in the NWP-10B, "Naval Warfare,"[3] are:

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[3] NWP-10B, "Naval Warfare," Office of the Chief of Naval Operations.

* Destroy enemy air power
* Neutralize shore-based air power during a specific period
* Destroy enemy industrial potential
* Strike and isolate the amphibious objective area by
  - Interdiction of communications and transportation
  - Armed reconnaissance in force (ARREC)
  - Destroying enemy ground forces, close air support (CAS)
* Destroy enemy naval forces and shipping, war at sea (WAS).

These objectives are accomplished by the attack carrier strike force in mission assignments to its air wings. These missions are:

* Alpha strikes--To destroy enemy air power or enemy industrial potential.
* CAS/ARREC interdiction strikes--To accomplish the strike tasks in the amphibious objective area.
* WAS strikes--To accomplish strikes at sea.
* Blockade missions--To neutralize enemy forces for specific periods.

Previous research had looked at alpha strikes and blockade missions. The SRI researchers were determined to find out whether the SOC was flexible enough to cover all the stated strike objectives. As a result, a CAS/ARREC problem was formulated and examined with the SOC. A formulation and analysis of that research is given in Section II-C-2.

1. Range of Tactical Questions Addressed

NWRC-TR-14 has identified the general types of decisions that might be required for a task force commander in determining the course of action for an air strike mission.[1] These general decision types are:

(1) Positioning of forces

(2) Use of assets

(3) Timing of events.

Many general factors such as force composition, capability, mobility, threat intentions, weather, and support factors affect these general decisions. In fact, each decision type is made up of many lesser-magnitude

decisions. It was found during the research performed to date, which includes the CAS/ARREC problem formulation, that the SOC could aid in answering a wide variety of tactical and contingency questions. Examples of such questions are shown in Table 1.

The TFC routinely poses such tactical and contingency questions to himself when he is formulating or reviewing his strike plan. The strike plan should normally address itself to a solution of these questions. In order to accomplish this feat a staff planner must conduct an effectiveness/attrition calculation such as shown in Appendix D of this report; this is a process of several hours duration. With its interactive capability the SOC can solve the effectiveness/attrition calculation in a matter of minutes. The SOC can compare estimated outcomes for each of these tactical or contingency questions in a very short time.

2. Problem Construction

The SRI staff sought to determine whether the SOC was flexible enough to handle a variety of naval strike scenarios and also to find out if the SOC formulation estimated results that could be manually constructed. To meet this objective, SRI decided to leave the strike and blockade scenarios it had been using in developing the SOC, and move into a new area. SRI chose the scenario and concept of operations from NWRC RM-86, "Amphibious Warfare Scenario."[4] This Close Air Support/Armed Reconnaissance (CAS/ARREC) oriented scenario provided fresh yet related material for the research. The strike plan was formulated using the steps indicated in the experimental booklet, "SOC Problem Definition" (Appendix B). The exercise summary is presented in the rest of this section, while the detailed computations and problem formulations are shown in Appendices D and E.

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[4] J. V. Rowney, Amphibious Warfare Scenario, Research Memorandum NWRC-RM-86, Contract N00014-75-C-0742, Stanford Research Institute, Menlo Park, California (October 1975).

Table 1

RANGE OF TACTICAL AND CONTINGENCY QUESTIONS FOR SOC

Positioning of Forces

- Should the TF position be at long range or short range from the enemy complex?

Use of Assets

- How many sorties of the following types are required to accomplish the mission:
  - Strike
  - Escort
  - Suppression
  - Combat air patrol (CAP)
  - Surface combat air patrol (SUCAP)?
- What assets are required to accomplish the mission in the shortest number of days?
- What is Blue/Red attrition for each case?
- At what threat level does Blue lose the battle?
- What is lowest number of Blue aircraft (VA, VF, or VA + VF) required to win the battle?
- What is the best distribution of assets among alternative bases?
- What is the Blue tradeoff consideration between DLI and CAP?
- What is the effect of Blue's win on the number of days of battle for variation in:
  - CV turnaround time
  - CV cycle time
  - DLI launch rate
  - Blue aircraft sortie rate?
- What is the minimum number of surface units needed to defend the carrier assuming no CAP or DLI?
- How will the employment of various strike tactics or weapon loading affect the final objectives or the number of days in the battle?

Timing of Events

- On what day of battle are the objectives achieved?
- Which missions are not filled successfully and to what degree?
- At what time and due to what force are Blue losses taking place?
- What is the impact, on the number of days of battle, of:

  a. Good or bad weather?

  b. Variation in aircraft numbers?

a. General Planning Procedure

The first step for the planner in developing the strike plan is to study the commander's mission, estimate of the situation and concept of operations, and the assets and capabilities of each combatant. From these general concepts the planner determines the number of sorties he can use for the necessary events, and the required tactics and weapons needed (or available) to be effective to the desired degree. From intelligence estimates the planner can forecast certain enemy actions and reactions and thereby estimate the scope of engagements in which his forces will be involved. Attrition and effectiveness data are collected from all sources available. Historical data and experience factors are as important as past analytical studies in arriving at good engagement parameters. After events are determined from the concept of operations and the estimated threat actions, losses are computed for each force in each event and totaled for the day. Accounting is maintained for cumulative losses over the several days of the battle.

b. Manual Construction

The scenario analyzed is a purely hypothetical description of war between Grey and Orange in which Blue intervenes with an amphibious force (ATF-6) supported by a two-carrier task force. The details of the estimate of the situation that lead to the concept of operations are shown in Appendix D.

The Blue concept of operations for the CAS/ARREC strikes established the need for certain numbers of CAS and ARREC strike aircraft, combat air patrols over the task force, air superiority patrols over the operation area, target CAP patrols over the FEBA, and a surface CAP patrol for enemy shipping.

The manual procedure computed the sorties necessary to fulfill the above events and also devised strike tactics and weapon loadings. In this problem, the events for the problem were repeated the same way each day for purposes of simplification. Actual events would probably be changed frequently. This can be done in more advanced problems, but

calculations are prohibitively complicated. Each event was handled in a game fashion--i.e., one side attacks, the other defends, and vice versa until one or the other of the air forces is expended.

The foregoing manual techniques of developing a strike estimate are represetnative of the process that could be used by the plan planner or staff operations officer in developing a strike plan. This analysis took 12 hours for an experienced analyst to develop. It may take more time for inexperienced naval personnel if they are not familiar with such factors as attrition, effectiveness, and threat tactics.

Some procedures in this manual technique are of vital importance in the actual development of a strike plan. These are:

(1) Allocation of aircraft and estimate of their sortie rate in the execution of the strike and the strike support.

(2) Weapon loading and tactical delivery, designed to arrive at maximum strike effectiveness and minimum attrition

(3) Weather contingency planning.

c. SOC Augmentation

The same inputs to the CAS/ARREC manual strike problem are used in the SOC computer format Appendix E (Tables 1 through 14) and the problem was repeated in order to compare results and credibility with the SOC automated decision aid. In the SOC augmentation, special attention must be given to the following areas:

(1) Strike and defense units consisting of various numbers of aircraft must be determined.

(2) Engagement statistics are calculated for the unit instead of an individual aircraft.

(3) Care must be taken in setting the correct objective and associated stop criteria for each mission.

The procedure of setting up the same problem in the automated format and making a verifying run took 4 hours.

d. Manual-SOC Comparison

When the base case was examined by the SRI staff, the results were found to be very similar. A comparison of aircraft losses is shown in Table 2.

Table 2

COMPARISON OF AIRCRAFT LOSSES

Initial Blue Aircraft	Manual	Computer
36 A-18	2	6
24 A-6	2	1
48 F-18	45	32
24 F-14	20	20
Initial Red Aircraft		
48 Bombers	40	48
144 VFI	110	120
48 VBF	40	20

A more detailed analysis than is indicated in the table was undertaken to examine individual raids and operations, independent of the whole battle, and comparisons were generated. These detailed isolated looks at the battle required extensive hours of analysis and did uncover some differences in the approaches due to differing assumptions in the two methods. Primarily, the differences lie in the fact that the human decision maker, using the manual method, can interject judgment at identified future points in time while carrying out the day-by-day analysis. Given the assumptions of the SOC however, the SOC results appear to be valid and consistent with the scenario.

Besides the time advantage accrued by the SOC in initially structuring the problem (4 hours compared to 12 hours), the great advantage

of the SOC is its very easy procedure for making a change in the plan, or testing a contingency course of action. Even a complicated change in the strike plan may only take 15 or 20 minutes on the SOC, whereas the manual calculations must be completely redone. It is this interactive ability of the SOC to quickly test various courses of action that makes it a very promising decision aid.

III SOC SENSITIVITY ANALYSIS AND VALIDATION

The sensitivity analysis and validation described in this section are defined in terms of an input/output analysis. Independent (input) variables were changed using the SOC in a systematic fashion, and the resulting effects on the dependent (output) variables were analyzed. This was done to ensure that the SOC gives credible results (i.e., increases in Blue assets shorten the battle duration or have no effect on it), and to identify decision factors and parameters that are most sensitive to change. Where appropriate, comparison of these outcomes with the opinions, guidelines, assumptions, and estimates of Naval users were examined. The sensitivity analysis spanned varying scenarios. The analysis was divided into the following areas:

- Definition of units
- Engagement statistics
- Numbers of assets
- Operations plans
- Weather.

Each area corresponds to an input table for the SOC. The analysis for each area was carried out on a particular scenario. These areas and the associated results are discussed in the following sections.

1. Definition of Units

Unit definition defines the strike and defense units, with their associated aircraft components. Units are defined so as to capture synergistic aircraft effects. Attrition is measured uniformly against these units. As a result, care must be taken in constructing them and they must be described as close to real life as possible. For instance, real life escort tactics attempt to engage the enemy defenders and shield the friendly attack planes. Therefore the escort unit in the model should be separated from the attack units and should lead the flight in at higher

speed and be detected earlier so as to ensure engagement by the defending interceptors before they engage the attack units. If escort speed is too high and enemy detection range is too low, the defending interceptors cannot intercept and no engagement results. On the other hand, if the escort fighters and attack planes are included in one unit, the enemy interceptor attacks the unit as a whole and attack plane attrition is unreasonably higher. If unit definitions are changed, engagement statistics for the unit must be changed.

2. Engagement Statistics

By far the most sensitive parameters in the SOC are the aircraft capabilities reflected in their effectiveness/attrition parameters. These engagement statistics for Blue attacking Red and Red attacking Blue are fairly aggregate measures of battle effectiveness of the force units that have been previously defined. The effectiveness and attrition of these attacking units should be specified by the staff planners using all kinds of data that may help in defining these parameters. These kinds of data may include historical facts, weapon effectiveness studies, actual experience, and a knowledge of the performance capability (or training factors) of the air wings. An important element in selecting such parameters is the consideration of the synergistic effects of the various assets in the unit (i.e., strike support forces such as escort fights, ECM aircraft, reconnaissance aircraft, etc.). The importance of such synergistic effects as well as the insertion of the users' judgment were primary factors in the decision to treat force assets in terms of units.

The SOC engagement statistics are structured to allow for the entry of much user judgment and experience. Some battle models similar to SOC allow users to input numerous and more detailed factual information, and then hidden within the model are assumptions, doctrines, and numerical techniques that interact to generate the intermediate (and still hidden) results necessary to obtain outcomes. This second approach allows little flexibility for the decision maker. A short example might help to clarify this point. Within the SOC, attrition data are required to reflect

the interaction of the opposing force units. The SOC input that describes this type of interaction deals with an immediate estimate of the aircraft losses within a defined unit, integrating basic performance facts with the decision maker's judgment and experience. Other battle models use input such as aircraft missile loadings, P_k values, and radar ranges (to name a few), and then apply algorithms that assume specific tactical doctrine, one-on-one engagement rules, independent missile firings, and the like, to arrive at results similar to the SOC input. The intelligent user can readily see that any confidence he may gain by inputting the more detailed raw data of the second approach is lost by the rigidity and nontransparency produced within such an approach. In summary, the decision maker using the SOC is allowed to interject his own belief about the engagement statistics, to the degree that he desires, and to observe the outcomes. He makes decisions based upon his own beliefs and assumptions.

Four tests were conducted, varying the engagement input parameters in order to check model output sensitivity and validity. These input changes were:

(1) A reduction of F-14 air-to-air capability by 50%.
(2) An increase in A7/A6 attrition at the target.
(3) A decrease in A7/A6 attrition at the target.
(4) Addition of a synergistic effort to represent the value of strike support forces such as ECM, AEW and Reconnaissance.

The first test above involved reducing the air-to-air exchange ratio of the F-14 and MIG-21. In lieu of the 4-to-1 superiority of the F-14 a 2-to-1 ratio was used.

The model results for the reduced F-14 capability compared to the full F-14 capability show no change in Blue attack attrition, Red attrition (remained at 100%), or battle time (Blue won in 2 days). The only change was in Blue VF attrition, which increased from 42% losses to 73% losses. The fact that this number did not double might indicate that excess F-14s were engaged in the original scenario.

Tests 2 and 3 above indicated an increase/decrease of A7/A6 attrition. These numbers were doubled for high attrition and halved for low attrition The model output resulted in similar values. A7/A6 losses were doubled for high attrition and halved for low attrition from the original run. No other changes resulted except that battle time was extended to 3 days for the Blue win when A7/A6 attrition was high.

Test 4 above allowed the best performance for the Blue strike. The attrition values were reduced 20% for Red interceptors and 50% for SAM losses, on the assumption that Blue ECM and strike control (AEW) aircraft were successful in reducing enemy attrition on the Blue strike aircraft. The model results showed a Blue attack attrition reduced from 41% to 6%, and a small reduction in VF attrition.

3. Numbers of Assets

The following variations in aircraft numbers were examined during the analysis:

- Blue VA aircraft were varied over a range of 24 to 72 aircraft.
- Blue VF aircraft were varied the same as the VA aircraft.
- Both Blue VA and VF aircraft were varied together.
- The number of Red SLI at ONRODA was varied.

The numbers associated with the results are not important in an absolute sense because they are scenario-dependent. The relative variation in the results is, however, and these results are given below. They reflect changes in the battle outcome that a planner might suspect.

In general Blue was not able to accomplish his offensive air objectives when the number of Blue VA aircraft were reduced below 24 aircraft. Blue's VF compliment, held at 48, was sufficient to discourage Red's attack and therefore the battle tended to go to a 10 day stalemate under these conditions.

When the Blue VF aircraft are reduced to 24 or below, Blue is not adequately defended both at the CTF and during the strike; therefore, Red wins the battle in approximately two days but suffers high attrition in doing so.

An increase of Red interceptors (SLI) increases the difficulty that Blue has in meeting his objectives. At 72 SLI, Blue requires 2 days to win, and at 97 SLI Blue requires three days to win. At 120 SLI the battle changes dramatically and Red wins in one day. Blue fails to meet his objectives at about 107 SLI. This monotonic increase in battle results is to be expected and follows intuitive belief.

The variations of aircraft number discussed above were calculated on the SOC, using its interactive capability, in about 1 hour. The results are reasonable--i.e., what an experienced planner might expect.

4. <u>Operations Plans</u>

The timing, use of assets, and threat action are specified in Blue and Red Operations Plan tables. Each offensive and defensive mission is defined by specifying a mission name, flight priority, origin complex, target complex, associated mission times, types of units, desired number of units, minimum number of units, and number of ready units. Force attrition is normally sensitive to the number of enemy interceptors that can be launched against the incoming raids. Interceptors, of course, should be used sparingly; therefore, the operations plan should show the DLI or SLI missions <u>during the periods of the enemy raids</u>. This is done because DLI or SLI aircraft are counted as generating sorties even though they may engage no attackers during a period.

Care must be taken that each mission is given a proper stop criterion to determine its success in meeting its objective, and for triggering other missions.

5. <u>Weather</u>

There is provision in the model to change weather at the target and enroute, each day, from good weather to bad weather. Two weather comparisons were made for this analysis. One involved a war with good weather each day versus a war where the first day was good and the subsequent days were bad weather. During good weather, normal strikes composed of A-7 attack aircraft are called out in the operations plan. A bad

weather contingency is planned, however. If bad weather occurs after the first day, A-6 aircraft are substituted. The model automatically makes this substitution if a weather change is made. Since there are not as many A-6 as A-7 aircraft in the Blue Task Force, one would expect that it would take more days to accomplish battle objectives. This result was the major difference in the two weather runs. In good weather Blue win in two days and Red's losses were 100%. In bad weather, Blue needed four days to win and Red losses were lower by 12%. The Blue attrition remained about the same.

6. SOC Limitations

During the research and demonstrations associated with the SOC, limitations were identified that potential planners should be made aware of. Real-world strike planning is extremely complicated and each and every component is hard to reflect arithmetically. The following list reflects the limitations in using and understanding the SOC.

- All effectiveness/attrition data were assumed to be linear functions of the number of engaging units. In actual use, both of these functions--effectiveness and attrition--are highly nonlinear during the course of the battle.
- The use of the terms OA (offensive air) and DA (defensive air) is confusing and inflexible, and may cause incorrect results. Some aircraft such as the MIG-21 may be used both offensively and defensively. The confusion or difficulty is that one must assign the numbers or types to be used offensively and defensively. The MIG-21 can be used as a VFI (DA) or as a VFB (OA), but cannot be changed in the model during the battle.
- The model may be too general with regard to the weather criteria.
- The synergistic effects of support aircraft are treated in a highly aggregated manner.
- The model is not flexible to the extent that mission cycles can be readily changed from the programmed three hours, to, say, 2 or 4 hours.
- DLI and SLI missions account for sortie expenditure even though such aircraft may not engage in battle during a time period.

Appendix A

INTRODUCTION TO THE SOC BOOKLET

August 1977

INTRODUCTION TO THE STRIKE OUTCOME CALCULATOR

Prepared by

NAVAL WARFARE RESEARCH CENTER
SRI INTERNATIONAL

I INTRODUCTION

The Office of Naval Research (ONR) is presently pursuing a five year multicontractor program to promote the development of decision aids and procedures in support of Fleet operations. The essential objective of the work is to improve tactical decision-making by blending a number of technologies such as decision-analysis, computer-driven graphic displays, advanced data management systems, information feedback, mathematical prediction, tactical models, and organizational analysis into a practical system for shipboard use. Concentrating on the task force commander and his staff, the project emphasizes decision aids that are designed to take advantage of the experienced judgments of senior officers in the operational situation, rather than relying on the predictions of system designers. In the operational situation these aids will provide guidelines and tools for the structuring of decision problems, eliciting judgments of probabilities and outcome preferences, furnishing stored data and models as requested by the decision maker, making statistical inferences, and displaying the implications of trial tactics prior to their execution. All of these objectives are compatible with ongoing command-control hardware programs. Decision makers will be provided with a man-computer interactive capability to help them examine and evaluate alternative courses of action.

SRI International (formerly Stanford Research Institute) has been a continuing participant in the program, and is now soliciting your assistance and support in evaluating an evolving concept in Task Force decision-aiding procedures, the Strike Outcome Calculator (SOC). The SOC is an automated decision aid for use in estimating outcomes associated with naval air strike courses of action. The purpose of the current research is to test the SOC concept by hypothesizing a tactical environment that is as realistic as possible, and by using the experienced judgment of officers charged with the responsibility for this type of planning. SRI's

goal is to make the SOC as responsive as possible to the planning needs of a typical Carrier Group Commander and his staff.

To date research on the SOC has been limited to naval air strike warfare and air defense, so that the utility of the concept could be examined within a bounded framework. The Strike Outcome Calculator consists of a computational algorithm, a media (i.e., terminal) for communicating inputs and outputs, and the required interface with the user. The prototype SOC has been successfully demonstrated in the research environment, and it is now necessary to elicit and record command reactions to its usage as a decision aid. The objective is to take into account recommendations made by Fleet users for improvement and redesign.

The role of outcome calculation is best seen in Figure 1, which has been adapted from the Navy planning manual, NWP 11(B). Outcome calculation also has application in the supervision of planned action phases (i.e., with changing events), although for now the focus is on the former role. Currently, outcome calculators in use by the Fleet consist primarily of officers calling upon their experience, empirical data, and qualitative judgment to estimate outcomes associated with possible situations.

The present research objective of SRI is to evaluate and refine the SOC concept, as set forth in the ongoing research by the Naval Warfare Research Center (NWRC), so as to provide a SOC prototype that is acceptable in the Fleet environment and operates efficiently in that environment. As stated previously, in order to meet this objective, it is necessary to elicit and record command reactions to the use of the SOC as a decision aid. Before this command reaction can be beneficial, SRI feels that qualified Navy officers should attempt to fill the role that the SOC is designed to meet by using methods with which they are currently familiar. This will provide a baseline from which comparative judgments can be made. To this end, SRI has structured a naval strike scenario and has posed a problem for qualified naval officers to solve by using methods familiar to them. After the officers have completed the problem and recorded the results of their planning, the research

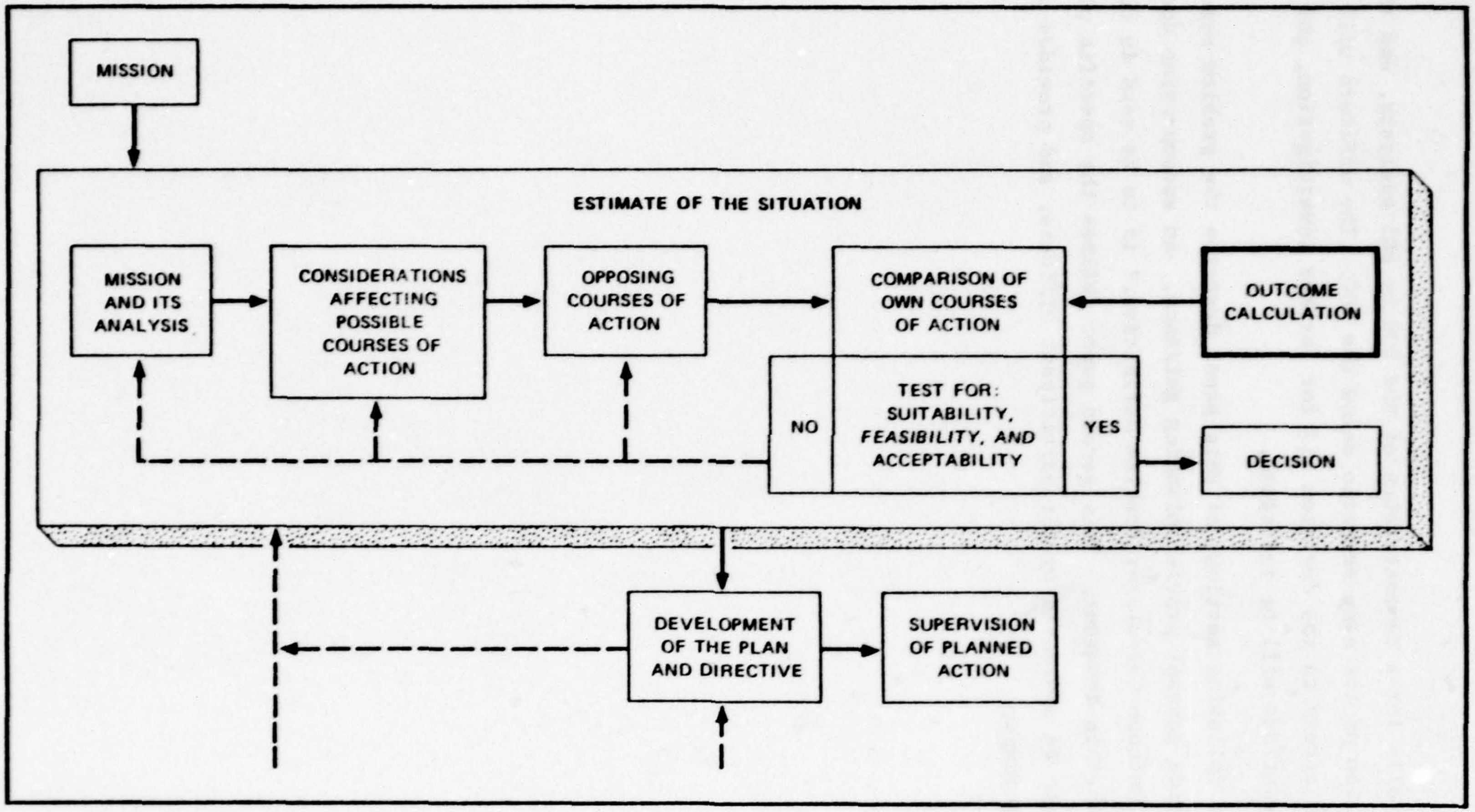

FIGURE 1 THE MILITARY PLANNING PROCESS (ESTIMATE PHASE), FROM NWP 11 (B), MODIFIED

method calls for a demonstration of the SOC by SRI analysts, and then an examination of the same scenario using the SOC. The officers will then be given access to the decision aid for further investigation, and finally their reactions will be solicited.

The following sections of this paper describe the problem scenario and provide general problem planning guidance. An accompanying document, "Strike Outcome Calculator Problem Definition," is to be used in conjunction with this document. This second paper defines the specific planning problem to be addressed by the participant officers, and provides additional guidance.

II PROBLEM SCENARIO

The problem scenario and planning guidance have been extracted from the following document: "ONRODA Warfare Scenario," Research Memorandum NWRC-RM-83, Stanford Research Institute, June 1975. This document can be used to augment the information presented in this paper if it is desired, however it is broader in its scope and differs with respect to a few of the details. Every effort has been made in this paper to present the major elements of the problem as simply as possible. A synopsis of the scenario follows.

Synopsis

Grey and Orange (see the map in Figure 2) have been ideologically opposed and hostile toward each other for a long time. Orange has supported rebel activities in Grey. ONRODA Island has been politically aligned with Grey, but has a significant segment of Orange sympathizers. Grey's military capability has diminished and Orange responds by more active support of the rebels in Grey and by capturing ONRODA Island. Blue has previously indicated that this was an unacceptable action, supported Grey's appeal to the UN, and asked for congressional approval for unilateral support of Grey if favorable UN reaction was not immediate. At the same time Blue orders the Fleet to prepare to stabilize the military situation in the area and prevent Orange from using ONRODA Island as a base for future military action against Grey. Red, who has supplied Orange with most of her combat systems, also has a naval force in the area. A Blue carrier task force is formed and given the mission: "When directed, begin operations to neutralize Orange forces and facilities on ONRODA Island in order to defend Grey. Do not attack targets on Orange mainland or in Orange ports. Take defensive measures to protect your force from Orange or Red retaliations."

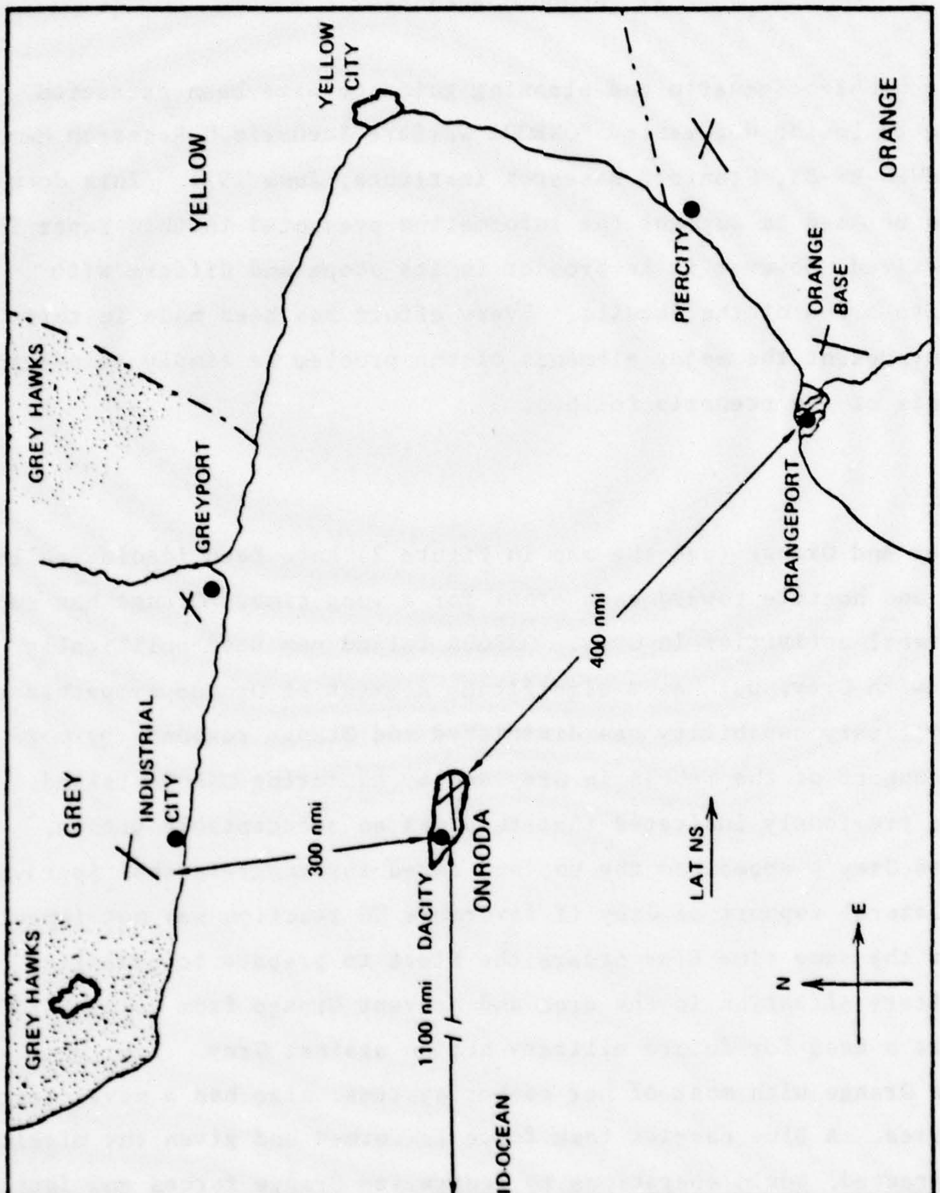

FIGURE 2 AREA MAP

The Blue task force is divided into two carrier groups and consists of the elements listed in Table 1. The enemy forces in the area are listed in Table 2.

Table 1

BLUE TASK FORCE MAJOR COMBATANTS

CARRIER GROUP ONE

Type	Class
CV	KITTY HAWK
CG	ALBANY
DDG	CHARLES F. ADAMS
DD	SPRUANCE
DD	GEARING (FRAM I)
DE	KNOX (with BPDMS and LAMPS)
DE	KNOX (with BPDMS and LAMPS)

CARRIER GROUP TWO

Type	Class
CV	FORRESTAL
CLG	converted CLEVELAND
DLG	LEAHY
DD	SPRUANCE
DD	GEARING (FRAM I)
DD	GEARING (FRAM I)
DE	KNOX (with BPDMS and LAMPS)

AIR WING COMPOSITION (each CV)

24	F-14
24	A-7E
12	A-6E
8	S-3A
5	E-2C
4	EA-6
4	KA-6
4	SH-3
1	C-1

Table 2

ENEMY MAJOR COMBATANTS

ORANGE NAVAL FORCES

Number	Type	Class
4	Destroyer	SKORY
6	Missile Boat	OSA-1
6	Missile Boat	KOMAR
12	Torpedo Boat	P6
2	Minesweeper	T-43
5	Amphibious Craft	VYDRA
2	Submarine	W

RED NAVAL FORCES

Number	Type	Class
1	Cruiser	KRESTA I
1	Destroyer	KASHIN
2	Submarine	ECHO II

ORANGE AIR FORCES

at ONRODA		at ORANGE	
24	MIG-19	48	MIG-19
72	MIG-21	72	MIG-21
48	SU-7	24	SU-7
24	IL-28	12	IL-28
		24	BADGER A

III PLANNING GUIDANCE

The Blue task force commander received the mission directive, called a staff meeting and took the following action:

- Ordered his Operations Officer to reschedule all ships in the task force to ensure that at least one carrier would continually be within air-strike distance of ONRODA Island and the southwest area of Grey. All ships were to continue operating under the existing operating orders until CTF-1 published a new op-order.
- Ordered daily intelligence briefings on the Orange/Grey situation.
- Ordered the Chief-of-Staff (COS) to be responsible for coordinating the op-order effort, i.e., by issuing (1) a dispatch format to Blue Fleet and CTG-2 stating Estimate of Situation, Course of Action, and Concept of Operations (due in 2 days) and, (2) the final written op-order with development of the plan (due in 10 days).
- Because he expected that higher authorities would consider the first Blue offensive actions as also significantly impacting on geopolitical and future strategic balances of power in this area of the world, he expressed his feeling to the staff that Blue strike action should commence only after a preemptive hostile action by Orange.

The tentative choices for Courses of Action that the staff developed were:

- Neutralize enemy forces by preemptive or reactive air strike*
- Neutralize enemy forces by air blockade
- Employ both reactive air strike and air blockade to neutralize enemy forces.

After much consideration, the task force commander selected the third alternative and ordered that a concept of operations be developed for the reactive air strike and subsequent air blockade.

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*Note: The different elements in a preemptive air strike as compared to a reactive air strike might be considered to be more surprise to the enemy, stronger offensive forces, higher mission accomplishment in less time and, less defensive forces needed.

Appendix B

SOC PROBLEM DEFINITION BOOKLET

August 1977

STRIKE OUTCOME CALCULATOR
PROBLEM DEFINITION

Prepared by

NAVAL WARFARE RESEARCH CENTER
SRI INTERNATIONAL

EXPERIENCE AND BACKGROUND OF PARTICIPANT

NAME______________________ RANK______________________

UNIT/ORG.______________________ PRESENT BILLET______________________

EXPERIENCE IN COMBAT OPERATIONS______________________ IN AIR STRIKE PLANNING______________________

I. INTRODUCTION

This document is a supplement to the document entitled "Introduction to the Strike Outcome Calculator." The purpose of this document is to set forth a concept of operations developed for the scenario given in "Introduction to the Strike Outcome Calculator," and to define a specific problem which is to be analyzed by participating naval officers. Planning guidance is given and is to be used as the participant chooses. Planners are not restricted to the guidance shown. Additionally, forms are presented, which are to be filled out after the problem has been completed. This will enable SRI analysts to capture information concerning current air strike planning procedures.

The problem is not a test or a reflection of the participant's abilities. Responses to the problem will be used by SRI to determine how current Fleet training and practices prepare naval officers to develop an acceptable air strike plan, what methods are typically used, and how well SRI's Strike Outcome Calculator compares with current practices.

Thank you for your participation.

II. CONCEPT OF OPERATIONS

The Blue Task Force will conduct air strike operations when directed against Orange forces on ONRODA Island in order to defend Grey.

The objective of this operation is to defend Grey from Orange air attacks, in particular from ONRODA Island. The physical objectives are the Orange combat aircraft and support facilities on ONRODA Island. A limitation is that Orange forces cannot be attacked in Orange mainland or in Orange ports. It is expected that no nuclear weapons will be used.

Red units may be sighted in the area. There is a low probability that Red will initiate hostile action toward Blue but Red is expected to harass and surveil individual Blue units. Orange units may also surveil the Blue forces before air strike operations begin. Blue forces are ordered not to take preemptive hostile action against such activities but to defend themselves by return fire if fired upon.

The two carrier groups making up the Blue task force will operate independently approximately 50 to 100 nmi apart. The strike launch point will be 400 nmi west of ONRODA Island. On the first strike day (S-day) four Alpha strikes will be launched against ONRODA; two strikes from each carrier. Each Alpha strike will be composed of 18 A-7, 6 A-6, 12 F-14 escort, 1 E-2 strike control, 1 EA-6 for EW, and 3 KA-6 refuelers. On each succeeding day (S+1, S+2, etc.) strike carrier duty will be alternated between carriers, each carrier launching two strikes a day. Additionally, an Intruder strike will be flown by four A-6s plus 2 F-14s at night. The Intruder strike composition will be substituted for the Alpha strikes if the weather turns bad. The off-duty strike carrier will fly the task force defensive sorties. "Clean-up" strikes are desired when the enemy defensive air assets have been reduced 50 percent. It is estimated that four strike days will be required to attrite the Orange air assets by 75 percent.

The defensive carrier will provide fighter aircraft to support three CAP stations during its 24-hour defensive duty. Each carrier group will provide its own ASW daily aircraft requirements. If enemy surface units threaten the task force, a SUCAP (surface cap) of A-7s and A-6s will be called upon. There is a high probability that Badger-A bombers escorted by MIG-21s with external tanks, may attack the task force from Orange mainland sometime after Blue strikes ONRODA.

After Orange aircraft are neutralized on ONRODA Island, the task force plans to change station to a point midway between ONRODA and Grey from which it will set up an air blockade to protect both Grey from attack and ONRODA from reinforcements.

III. PROBLEM DEFINITION

Develop a strike plan from the scenario description and the concept of operations that you would submit to the task force commander (TFC) in an op-order. Assume that Orange mounts strikes against Grey from ONRODA and this action triggers a Blue response. As a test of the feasibility and acceptability of your plan compute estimated air losses for both BLUE and ORANGE as well as possible ship damage. The Appendix presents certain data that can be used for this computation. These data are arbitrary to a certain degree and are unclassified.* The computed aircraft losses (outcomes) may be limited to the following:

BLUE losses

- A-7E
- A-6E
- F-14A

ORANGE losses

- Badger-A, Beagle,
- SU-7, MIG-19,
- MIG-21

For the purpose of the problem, assume that Orange attacks the Blue task force with Badger strikes from the Orange mainland soon after the Blue strikes on ONRODA. Additionally, the surviving Orange air forces on ONRODA are directed against the Blue task force from the second day on. Further, assume the Red cruiser enters the action with an SSM attack on the second day.

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*The data are not meant to become a focal point for debate. Additional data sources may be used if desired. These data are submitted to save data collection time, to keep the problem unclassified, and to maintain a certain degree of conformity.

The computed aircraft losses (outcomes) should be done for two cases; i.e., (1) good weather for the entire operation, and (2) the weather turns "bad" on the second day and remains bad for the rest of the problem. "Bad" weather is defined as a situation where A-6E strikes must be substituted for the A-7E sorties.

The objective of this exercise is to compare current strike outcome calculation techniques, to document the man-hours devoted to make such outcome estimates, and to compare methods and credibility with the SOC automated decision aid that will be demonstrated by SRI.

The following summary of the problem is presented in outline form to assist the planner in completing the problem:

Given:

The TFC's mission
The Estimate of the Situation and Selected Course of Action
The assets and capabilities of each combatant
The Concept of Operations

Problem:

Develop a strike plan
Test the plan for suitability, feasibility, and acceptability by computing or estimating own and enemy air losses and possible ship losses

Method of Approach:

Compute sorties necessary to fulfill concept of operations with reasonable sortie rates
Devise strike tactics and weapon loadings
Estimate enemy defenses and enemy counterattacks
Use given data to estimate attrition and effectiveness
Compute losses for each day considering the following as separate actions: air-to-air, air-to-surface, and surface-to-air engagement
Summarize losses

IV. PLANNING RESULTS

Please answer the following questions concerning the planning procedure you have just completed.

A. Total Time Spent on Assignment

Estimate the amount of time that you spent in reading and familiarizing yourself with the problem scenario, planning guidance, and problem definition. __________hrs.

Estimate the amount of time that you spent in analyzing the problem and in computing results. __________hrs.

The sum of the above estimates represents 100% of your work on the problem.

B. Tasks, Steps, and Procedures

- Indicate in column (a) the estimated amount of time that you spent on the stated task, step, or procedure. Use % of total time (of A above) if you prefer.
- In column (b) rate the difficulty of doing each line item, using the following scale:

  (1) Very easy, (2) Easy, (3) Moderately difficult,
  (4) Difficult, (5) Very difficult.
- In column (c) list the methodology that you used to solve each task. This includes any publications or analytical techniques that you used. List as many as apply.
- Add to the table, additional tasks, steps, or procedures that you utilized in working the problem, completing the above information for each.

Tasks, Steps, Procedures	(a) % of Time Spent	(b) Difficulty Rating	(c) Methodology (Publications, Analytic Techniques)
1. Reading and understanding the assignment.			
2. Understanding the tactical situation.			
3. Computing the Number of Sorties Required.			
4. Devising Strike Tactics and Weapon Loadings.			

Tasks, Steps, Procedures	(a) % of Time Spent	(b) Difficulty Rating	(c) Methodology (Publications, Analytic Techniques)
5. Estimating Enemy Defenses and Counter Attacks.			
6. Estimating Attrition and Effectiveness.			
7. Computing Air-to-Air Losses.			
8. Computing Air-to-Surface Losses.			

Tasks, Steps, Procedures	(a) % of Time Spent	(b) Difficulty Rating	(c) Methodology (Publications, Analytic Techniques)
9. Computing Surface-to-Air Losses.			
10. Summarizing Losses.			
11. Other (Specify).			
12.			

Tasks, Steps, Procedures	(a) % of Time Spent	(b) Difficulty Rating	(c) Methodology (Publications, Analytic Techniques)
13.			
14.			
15.			
16.			

C. Planning Comments

Add any comments that you think are appropriate regarding the air strike planning process, and the methods and publications employed in that process.

Appendix

DATA FOR PROBLEM ANALYSIS

Table 1

BLUE AIR CAPABILITY

TYPE	MISSION	SHORT RANGE PAYLOAD LBS	SHORT RANGE COMBAT RADIUS NM	SHORT RANGE MISSION TIME HRS	LONG RANGE PAYLOAD LBS	LONG RANGE COMBAT RADIUS NM	LONG RANGE MISSION TIME HRS	SORTIE RATE NORMAL/SURGE	REARM REFUEL HRS
F-14A	CAP FAD	(6PH*) 6000	150	2.4	--------NA--------			1/2	1.0
F-14A	DLI	(6PH) 6000	150	.6	--------NA--------			1/2	1.0
F-14A	ESCORT	(4SP + 4SW) 2800	250	1.0	2800	450	2.1	1/2	1.0
F-4J	CAP	(4SP + 4SW) 2800	150	1.8	--------NA--------			1/2	1.0
F-4J	DLI	2800	190	.7	--------NA--------			1/2	1.0
F-4J	ESCORT	2800	250	1.0	2800	400	1.8	1/2	1.0
F-4J	ATTACK	4000	250	1.0	4000	400	1.8	1/2	1.0
A-7E	ATTACK or SUCAP	7500	250	1.3	3000	450	2.3	1/2	2.0
A-6E	ATTACK or SUCAP AW ATTACK	12000	250	1.3	9000	450	2.3	1/2	2.5

*PH = PHOENIX Missile
SP = SPARROW Missile
SW = SIDEWINDER Missile

Table 2

RED AIR CAPABILITY

TYPE	MISSION	SHORT RANGE PAYLOAD LBS	SHORT RANGE COMBAT RADIUS NM	SHORT RANGE MISSION TIME HRS	LONG RANGE PAYLOAD LBS	LONG RANGE COMBAT RADIUS NM	LONG RANGE MISSION TIME HRS	SORTIE RATE NORMAL/SURGE	REARM REFUEL HRS
BADGER A	FREEFALL BOMB	10,000	1450	6.5	6600	1650	7.5	1/1.5	3.0
BADGER C	ASM	(1 AS-2) 9100	1450	6.5	9100	2000 R	10.0	1/1.5	3.0
BADGER G	ASM	(2 AS-5) 15,000	1200	6.0	15,000	1800 R	9.0	1/1.5	3.0
IL-28 BEAGLE	FREEFALL BOMB	6600	240	2.0	2200	570	4.0	1/1.5	2.0
FITTER A SU-7B	ATTACK VBF	4400	150	1.5	2200	300	2.0	1/2	1.0
FISHBED J MIG-21	ATTACK VBF	4400	230	1.5	2200	350	2.0	1/2	1.0
FARMER MIG-19	ATTACK VBF	1100	150	.7	500	390	1.7	1/2	1.0
FISHBED J MIG-21	INTERCEPT VFI	900	260	1.0	-----------NA-----------			1/2	1.0

Table 3

AIR-TO-AIR EXCHANGE RATIOS*
(BLUE TO RED)

	MIG-21	MIG-19/SU-7	BADGER	SSM
F-14	1/4	1/10	0/4	0/3
F-4	1/1	1/1.5	0/2.5	0/1.5
A-7	1/.67	1/1	0/1	NA
A-6	1/.67	1/1	0/1	NA

*These ratios do not reflect armament limitations.

Table 4

BLUE ATTACK AIRCRAFT ATTRITION FROM SAMS AND AAA
(per 1000 sorties)

AIRCRAFT	STRIKE		WAR AT SEA		INTERDICTION	
	SAM	AAA	SAM	AAA	SAM	AAA
A-7	15	3	3	--	5	3
A-6 Suppression	7	5	3	--	3	2
A-6 AW	2	1	1	--	1	1

Table 5

AIR-TO-GROUND Pk's

Good Weather (A-7 and A-6, CEP = 10 mils)

Target	Alt. (ft.)	Weapon*	Pk
Aircraft on ground	11000	2LGB	.9
	8000	4MK20	.7
Tank	11000	2WIDL	.9
Kresta	11000	4WIDL	.6
APC	11000	1WIDL	.9
SAM Site Radar	11000	1STDARM	.9
AAA	8000	4MK20	.2
Fuel Depot	5500	6MK83	.2

Bad Weather (A-6 radar bombing CEP = 300 ft.)

Target	Alt. (ft.)	Weapon	Pk
Aircraft on ground		8MK20	.4
Tank		8CPU59	.1
Kresta		2AGM53	.2
APC		8MK20	.1
SAM		12MK81	.1
AAA		8CBU59	.3

Note: (1) For Red freefall bombs (1000#) and SSM (1000# warhead) CEP = 1000′.

(2) For Red ASM or freefall attack on CVs, assume each impacting missile or bomb claims .1 damage.

* MK20 = Rockeye
WIDL = Walleye data link
CPU59 = Cluster weapon
AGM53 = Condor
MK81 = 250# bomb
LGB = Laser guided bomb Mk 82 or 83
STDARM = Standard ARM

Appendix C

SOC EVALUATION QUESTIONNAIRE BOOKLET

August 1977

STRIKE OUTCOME CALCULATOR
EVALUATION QUESTIONNAIRE

Prepared by

NAVAL WARFARE RESEARCH CENTER
SRI INTERNATIONAL

EXPERIENCE AND BACKGROUND OF PARTICIPANT

NAME ______________________ RANK ______________________

UNIT/ORG ______________________ PRESENT BILLET ______________________

EXPERIENCE IN COMBAT OPERATIONS ______________________ IN AIR STRIKE PLANNING ______________________

I. INTRODUCTION

The Strike Outcome Calculator (SOC) is designed to augment the task force commander's planning function by helping him to translate information about variables that are likely to affect his plans into estimates of outcomes for alternate courses of action.

The SOC is in the development stage and has been used thus far only for the planning of air strikes. This questionnaire solicits your inputs to determine: (1) how useful SOC appears to be as an aid for air strike planning, (2) how it might be improved for that purpose, and (3) how useful the concept might be for other planning functions.

Thank you for your participation.

II. CONTENT OF DISPLAYED FORMATS

Do you consider the information content presented[1] in the SOC displays to be fully adequate for air strike planning purposes?

[ ] yes [ ] no

If no, what needs to be improved? (check as many as apply).

[ ] Description of blue and red force elements (Exhibit 1)
[ ] Description of blue force units (Exhibit 2)
[ ] Description of red force units (Exhibit 3)
[ ] Engagement statistics for blue attacking red (Exhibit 4)
[ ] Engagement statistics for red attacking blue (Exhibit 5)
[ ] Weapon platform availability (Exhibit 6)
[ ] Capabilities of a/c related elements (Exhibit 7)
[ ] Blue force complexes (Exhibit 8)
[ ] Red force complexes (Exhibit 9)
[ ] Miscellaneous inputs (Exhibit 10)
[ ] Blue operations plans (Exhibit 11)
[ ] Red operations plans (Exhibit 12)
[ ] Relative complex positions (Exhibit 13)
[ ] Initiating wx days (Exhibit 14)
[ ] Blue mission accomplishment results (Exhibit 15)
[ ] Red mission accomplishment results (Exhibit 16)
[ ] Blue complex battle attrition results (Exhibit 17)
[ ] Red complex battle attrition results (Exhibit 18)

(continued on next page)

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[1] See Appendix for exhibits of SOC displays.

Write below what needs to be improved, added, or deleted (indicate which exhibit).

III. DISPLAY FORMATS

Do you consider the display formats presented[1] by the SOC to be fully adequate with regard to the layout and organization of the data?

[ ] yes   [ ] no

If no, which formats need to be improved? (check as many as apply).

[ ] All formats
[ ] Description of blue and red force elements (Exhibit 1)
[ ] Description of blue force units (Exhibit 2)
[ ] Description of red force units (Exhibit 3)
[ ] Engagement statistics for blue attacking red (Exhibit 4)
[ ] Engagement statistics for red attacking blue (Exhibit 5)
[ ] Weapon platform availability (Exhibit 6)
[ ] Capabilities of a/c related elements (Exhibit 7)
[ ] Blue force complexes (Exhibit 8)
[ ] Red force complexes (Exhibit 9)
[ ] Miscellaneous inputs (Exhibit 10)
[ ] Blue operations plans (Exhibit 11)
[ ] Red operations plans (Exhibit 12)
[ ] Relative complex positions (Exhibit 13)
[ ] Initiating wx days (Exhibit 14)
[ ] Blue mission accomplishment results (Exhibit 15)
[ ] Red mission accomplishment results (Exhibit 16)
[ ] Blue complex battle attrition results (Exhibit 17)
[ ] Red complex battle attrition results (Exhibit 18)

(continued on next page)

---

[1] See Appendix for exhibits of SOC displays.

Write below what needs to be improved to make the formats more usable.

IV. PRESENTATION AND USAGE OF DISPLAYED DATA

Do you consider the method of presentation and usage of displayed data to be fully adequate?

[ ] yes [ ] no

If no, which of the following need to be improved? (check as many as apply).

[ ] Display response time is too slow

[ ] Displayed data are too crowded and difficult to read

[ ] Procedures for finding appropriate display formats are not clear

[ ] Instructions for using the SOC are not clear

[ ] The use of asterisks for borders is annoying

[ ] The order of display usage is confusing

[ ] The quality of displayed imagery is marginal (e.g., character size too small, luminance too low, inadequate contrast)

[ ] Display screen size is too small

[ ] Usage of keyboard is too awkward or complex

[ ] Feedback is inadequate regarding format selection and usage

[ ] Other (specify) ______________________________

____

Write below any further comments on the presentation and usage of displayed data: ______________________________

____

____

____

____

____

____

____

____

V. EXTENSION OF THE SOC CONCEPT

The content of the prototype SOC is limited to the planning of air strikes, and to the data contained in the current formats. Would it be desirable to display additional information for the TFC and his staff using SOC equipment:

[ ] yes [ ] no

If yes, which of the following would you recommend having? (check as many as apply).

[ ] A listing of applicable publications about selected topics
[ ] A listing of formulas and examples to be used for planning
[ ] A listing of procedures to be used in planning
[ ] A listing of tactical procedures
[ ] Other (specify) ____________________

____

____

____

In which of the following areas should the SOC concept be tried?

[ ] Other warfare planning areas (specify below)
[ ] Logistics planning
[ ] Route planning
[ ] Order of battle planning
[ ] Rules of engagement planning
[ ] Target assessment and weapon selection planning
[ ] EW planning
[ ] None of these
[ ] Other (specify) ____________________

____

____

____

VI. SOC IMPLEMENTATION

The SOC is intended for the use of the TFC and his staff, or anyone else who is required to estimate the outcomes of air strikes. In your view, where should SOC displays be provided? (check as many as apply).

[ ] In the TFC's stateroom

[ ] In the flag plot

[ ] On the bridge

[ ] In designated staff members' quarters

[ ] In CIC

[ ] Other (specify) ______________________________

____

____

____

Who should operate the SOC?

[ ] The TFC

[ ] The chief of staff

[ ] Designated staff members

[ ] A specially trained operator

[ ] Other (specify) ______________________________

____

____

____

VII. SOC VALUE

Rate the value of the SOC as a planning aid, using the following 1-5 scale.

1 = Of Very Little Value [ ]

2 = Of Little Value [ ]

3 = Of Some Value [ ]

4 = Of Considerable Value [ ]

5 = Of Great Value [ ]

Write below any additional comments that you have concerning the subject matter in this questionnaire: ______________________________

Appendix

EXHIBITS OF SOC DISPLAYS

EXHIBIT 1

BLUE FORCE ELEMENTS

TYPE	ACTUAL	CLASS
ATTACK	A-7E	OA
AW-ATTACK	A-6E	OA
VF LO	F-4J	DA
VF HI	F-14A	DA
CV	KITTY HAWK	OS
SUPPORT SHIP	DLG LEAHY	DS

RED FORCE ELEMENTS

TYPE	ACTUAL	CLASS
BOMBER-LO	BADGER A	OA
BOMBER-HI	BADGER C	OA
VBF	SU-7B	DA
VFI	MIG-21	DA
SSM-SHIP	SS-N-3	OS
AIRBASE	ONRODA	OS
SAM SITE	SAM-3	DS
SUPPLY LINE	AAA	LS

OA-OFFENSIVE AIR
DA DEFENSIVE AIR
OS-OFFENSIVE SURFACE
DS-DEFENSIVE SURFACE
LS-LOGISTICS SUPPORT

EXHIBIT 2

BLUE FORCE UNITS

B FRC UNIT		ELEMENTS PER UNIT					UNIT CHARACTERISTICS					
TYPE	SUB	VA	AW	VF LO	VF HI	SUP A/C	MAX RANGE	RANGE DEF SUB	WORST WX	WX DEF SUB	MAX DET (NM)	SPEED (MACH)
ALPHA	A	3				1	LONG		GOOD	C	100	.9
ALPHA	B	3				1	LONG		GOOD	C	100	.9
ALPHA	C		2				LONG		BAD		100	.9
ESCOR	A				1		LONG		GOOD	C	100	.9
ESCOR	C				1		LONG		BAD		100	.9
SUCAP		1	1				LONG		BAD		100	.9
VFCAP					1		SHORT		BAD		100	2.2
DLI					1		SHORT		BAD		100	2.2

EXHIBIT 3

RED FORCE UNITS

R FRC UNIT TYPE	SUB	BR LO	BR HI	VBF	VFI	SSM SHP	MAX RANGE	RANGE DEF SUB	WORST WX	WX DEF SUB	MAX DET (NM)	SPEED (MACH)
		ELEMENTS PER UNIT					UNIT CHARACTERISTICS					
FREE	A	4		4			LONG		GOOD	B	300	.9
FREE	B	4					LONG		BAD		300	.9
VBF	A			8			LONG		GOOD		300	.9
SSM						1	SHORT		GOOD		200	.9
SLI					1		SHORT		BAD			1.5

EXHIBIT 4

ENGAGEMENT STATISTICS FOR BLUE ATTACKING RED

BLUE FORCE UNIT TYPE	SUB	VBF	VFI	SAM	SPLY LINE	VBF	VFI	PKED A/C	SSM SHIP	AIR BASE	SAM	SPLY LINE
		BLUE UNITS LOST PER RED DEF ELEMENT				MAX RED AIR LOST PER BLUE UNIT		RED SURFACE ELEMENTS LOST PER BLUE UNIT				
ALPHA	A	.12	.25	.052		4	2.7	2.7			.9	
ALPHA	B	.12	.25	.052		4	2.7	5.4			.9	
ALPHA	C	.12	.25	.004		1	.67	.8				
ESCOR	A	.1	.25			4	4.					
ESCOR	C	.05	.12			2	2.					
SUCAP		.5	.5	.006		2	1.3		.6			

EXHIBIT 5

ENGAGEMENT STATISTICS FOR RED ATTACKING BLUE

RED FORCE UNIT TYPE	SUB	RED UNITS LOST PER BLUE DEF ELEMENT: VF LO	VF HI	CV	SUP SHIP	MAX BLUE AIR LOST PER RED UNIT: VF LO	VF HI	BLUE SURFACE ELEMENTS LOST PER RED UNIT: PARKED A/C	CV	SUPPORT SHIPS
FREE	A	.22	.5		.37	4	1		.2	.5
FREE	B	.62	1.		.75					.5
VBF	A	.12	.5	.12	.37	8	2	2		.2
SSM		.19	.37	.19	.28				.2	

EXHIBIT 6

WEAPON PLATFORM AVAILABILITY

FORCE ELEMENT	NORMAL SR	SURGE SR	R/R TIME
BLUE			
VA	1	2	1
AW	1	2	1
VF LO	1	2	1
VF HI	1	2	1
RED			
BR LO	1	1.5	1
BR HI	1	2	1
VBF	1	2	1
VFI	1	2	1
SSMSHIP	1	2	4

EXHIBIT 7

CAPABILITIES OF A/C RELATED ELEMENTS

DAMAGE LEVEL	MAX OPERATIONS PER PERIOD: BLUE CV	MAX OPERATIONS PER PERIOD: RED AIRBASE	MAX DMGE REPAIR PER PERIOD: BLUE CV	MAX DMGE REPAIR PER PERIOD: RED AIRBASE
0.0	250	300	0	0
.1	225	260	.07	.07
.2	200	230	.12	.12
.3	125	200	.15	.15
.4	100	175	.16	.16
.5	75	150	.15	.15
.6	24	24	.12	.12
.7	24	24	.07	.07
.8	0	0	0	0
.9	0	0	0	0
1.0	0	0	0	0

EXHIBIT 8

BLUE FORCE COMPLEXES

BLUE COMPLEX	ELEMENTS: VA	AW	VF LO	VF HI	CV	SUP SHIPS	CHARACTERISTICS: DLI LNCH TIME (MIN)	SURV RANGE FACT	FRACT A/C SHELT	CYCL TIME DAYS	REPL TIME DAYS	REPL OPS
CTFRC	48	24	0	48	2	12	.5	1	.3	4	1	50

EXHIBIT 9

RED FORCE COMPLEXES

RED COMPLEX	BR LO	BR HI	VBF	VFI	SSM SHP	AIR BSE	SAM STE	SLY LNE	SLI LNCH TIME (MIN)	SURV RANGE FACT	FRACT A/C SHELT	CYCL TIME DAYS	REPL TIME DAYS	REPL OPS
ONRAF	24	0	72	72		1	18	0	.5	1	0	6	2	50
ORGAF	36	0	72	72		1	27	0	.5	1	.3	6	1	50
REDCA					1					1	0	4	1	

Column groups: ELEMENTS (BR LO through SLY LNE); CHARACTERISTICS (SLI LNCH TIME through REPL OPS).

EXHIBIT 10

MISCELLANEOUS INPUTS

MAXIMUM NUMBER OF DAYS THE BATTLE IS TO RUN(LESS THAN 31)	10
MISSION TIME FOR LONG RANGE MISSIONS(NO. OF 3HR TIME STEPS)	0
MISSION TIME FOR SHORT RANGE MISSIONS(NO. OF 3HR TIME STEPS)	0
NO. OF OPERATIONS PER AIRCRAFT LANDING	2
NO. OF OPERATIONS PER AIRCRAFT LAUNCH	1
FRACTION OF MAX UNIT DETECTION RANGE REALIZED IN BAD WEATHER	.5
DELAY IN MINUTES BEFORE FIRST SLI/DLI CAN BE LAUNCHED	3
DO YOU WANT LONG RANGE FORCE UNIT DEFAULT IN EFFECT(1=YES 0=NO)	1
DO YOU WANT BAD WEATHER FORCE UNIT DEFAULT IN EFFECT(1=YES 0=NO)	1

EXHIBIT 11

BLUE OPERATIONS PLANS

MISSION	P	ORIGIN COMPLX	TARGET COMPLX	START	STOP	MISSION TIMES	UNIT TYPE	UNIT SUB	DES UNT	MIN UNT	RDY UNT
ESCR1	2	CTFRC	ONRAF	DAY 1	DAY 1	1234	ESCOR	A	12	4	
STRK1	2	CTFRC	ONRAF	DAY 1	DAY 1	1234	ALPHA	A	6	4	
ESCR3	2	CTFRC	ONRAF	DAY 2	DDA 75	13	ESCOR	A	12	4	
STRK3	2	CTFRC	ONRAF	DAY 2	DDA 75	13	ALPHA	A	6	4	
ESCR4	2	CTFRC	ONRAF	DDA 75	DOA 75	13	ESCOR	A	6	4	
CLEAN	2	CTFRC	ONRAF	DDA 75	DOA 75	13	ALPHA	B	6	4	
ESCR2	2	CTFRC	ONRAF	DAY 1	DOA 75	6	ESCOR	C	2	1	
STRK2	2	CTFRC	ONRAF	DAY 1	DOA 75	6	ALPHA	C	2	1	
CAP1	1	CTFRC		DAY 1	ENDSTRK3	12345678	VFCAP		3	1	
DLI1	1	CTFRC		DAY 1	ENDSTRK3	23	DLI		1	1	
CAP2	1	CTFRC		ENDSTRK3	ENDCLEAN	12345678	VFCAP		1	1	
DLI2	1	CTFRC		ENDSTRK3	ENDCLEAN	23	DLI		1	1	
SUCAP	1	CTFRC	REDCA	DAY 1	DOS 100	1234	SUCAP		1	1	

EXHIBIT 12

RED OPERATIONS PLANS

MISSION	P	ORIGIN COMPLX	TARGET COMPLX	START	STOP	MISSION TIMES	UNIT TYPE	UNIT SUB	DES UNT	MIN UNT	RDY UNT
VBFHT	1	ONRAF	CTFRC	DAY 2	DOA 50	23	VHF	A	2	1	
FREE	2	ORGAF	CTFRC	DAY 1	DOA 50	23	FREE	A	3	2	
SLI1	1	ONRAF		DAY 1		1234	SLI		16	1	
SSMHT	1	REDCA	CTFRC	DAY 2	DOA 50	23	SSM		2	1	

EXHIBIT 13

RELATIVE COMPLEX POSITIONS

BLUE								
RED	CTFRC							
ONRAF	LONG							
ORGAF	LONG							
REDCA	SHORT							

EXHIBIT 14

INITIATING WX DAYS

DAY	1									
WX	GOOD									

EXHIBIT 15

BLUE MISSION ACCOMPLISHMENT RESULTS

MISSION	P	ORIGIN COMPLX	TARGET COMPLX	START	STOP	MISSION TIMES	UNIT TYPE	SUB	DES UNT	UNT REQ	UNT ENG
ESCR1	2	CTFRC	ONRAF	DAY 1	DAY 1	1234	ESCOR	A	12	48	48
STRK1	2	CTFRC	ONRAF	DAY 1	DAY 1	1234	ALPHA	A	6	24	24
ESCR3	2	CTFRC	ONRAF	DAY 2	DAY 2	13	ESCOR	A	12	24	24
STRK3	2	CTFRC	ONRAF	DAY 2	DAY 2	13	ALPHA	A	6	12	12
ESCR4	2	CTFRC	ONRAF	DAY 3	DAY 2	13	ESCOR	A	6	0	0
CLEAN	2	CTFRC	ONRAF	DAY 3	DAY 2	13	ALPHA	B	6	0	0
ESCR2	2	CTFRC	ONRAF	DAY 1	DAY 2	6	ESCOR	C	2	4	0
STRK2	2	CTFRC	ONRAF	DAY 1	DAY 2	6	ALPHA	C	2	4	4
CAP1	1	CTFRC		DAY 1	DAY 2	12345678	VFCAP		3	48	48
DLI1.	1	CTFRC		DAY 1	DAY 2	23	DLI		1	4	4
CAP2	1	CTFRC		DAY 3	DAY 2	12345678	VFCAP		1	0	0
DLI2	1	CTFRC		DAY 3	DAY 2	23	DLI		1	0	0
SUCAP	1	CTFRC	REDCA	DAY 1	DOS 100	1234	SUCAP		1	8	8

EXHIBIT 16

RED MISSION ACCOMPLISHMENT RESULTS

MISSION	P	ORIGIN COMPLX	TARGET COMPLX	START	STOP	MISSION TIMES	UNIT TYPE	SUB	DES UNT	UNT REQ	UNT ENG
VBFHT	1	ONRAF	CTFRC	DAY 2	DOA 50	23	VBF	A	2	4	3
FREE	2	ORGAF	CTFRC	DAY 1	DOA 50	23	FREE	A	3	12	9
SLI1	1	ONRAF		DAY 1		1234	SLI		16	128	61
SSMHT	1	REDCA	CTFRC	DAY 2	DOA 50	23	SSM		2	4	1

EXHIBIT 17

BLUE COMPLEX BATTLE ATTRITION RESULTS

BLUE COMPLEX	VA	AW	VF LO	VF HI	CV	SUPSHIP
	ELEMENTS ATTRITED / TOTAL ELEMENTS AT COMPLEX					
CTFRC	14.	5.	0.	25.	0.0	0.0
	48.	24.	0.	48.	2.0	12.0

EXHIBIT 18

RED COMPLEX BATTLE ATTRITION RESULTS

RED COMPLEX	BR LO	BR HI	VBF	VFI	SSMSHIP	AIRBASE	SAM	SUPLINE
	ELEMENTS ATTRITED / TOTAL ELEMENTS AT COMPLEX							
ONRAF	24.	0.	72.	72.	0.0	0.0	18.0	0.0
	24.	0.	72.	72.	-0.0	1.0	18.0	0.0
ORGAF	36.	0.	36.	0.	0.0	0.0	0.0	0.0
	36.	0.	72.	72.	-0.0	1.0	27.0	0.0
REDCA	0.	0.	0.	0.	.6	0.0	0.0	0.0
	-0.	-0.	-0.	-0.	1.0	-0.0	-0.0	-0.0

Appendix D

CLOSE AIR SUPPORT STRIKE PLAN
MANUAL COMPUTATIONS

I GENERAL AIR STRIKE PROBLEM

The following summarizes the general considerations that impact on analyzing a general air strike problem:

- Given:
  - The TFC's mission
  - The estimate of the situation and selected course of action
  - The assets and capabilities of each combatant
  - The concept of operations.
- Problem:
  - Develop a strike plan.
  - Test the plan for suitability, feasibility, and acceptability by computing or estimating own and enemy air losses and possible ship losses.
- Method of Approach:
  - Compute sorties necessary to fulfill concept of operations with reasonable sortie rates.
  - Devise strike tactics and weapon loadings.
  - Estimate enemy defenses and enemy counterattacks.
  - Use given data to estimate attrition and effectiveness.
  - Compute losses for each day considering the following as separate actions: air-to-air, air-to-surface, and surface-to-air engagement.
  - Summarize losses.

The manual approach to solving the close air support problem closely follows the above method of approach. This appendix will briefly present the scenario situation, the assets and capabilities of each combatant, and the developed concept of operations, and will outline the method of approach on a time step (event) basis. Other than the method of approach, most of the material is condensed from NWRC/SRI RM-86, "Amphibious Warfare Scenario."[4]

II SCENARIO SITUATION

During December, two Orange reinforced motorized infantry divisions invaded Grey by way of Yellow City and captured Greyport with the help of Greyhawk insurgents. The UN authorized a counter force to stop this aggression and to set up a demilitarized zone on the Grey/Yellow border. The objective for this force was to seize Greyport airport and naval base, defeat the Orange forces in Grey, and establish the demilitarized zone.

The mission of Blue was to establish a beachhead by amphibious assault between the Grey/Orange FEBA west of Greyport in order to seize Greyport airport and naval base, defeat Orange forces in Grey, and establish a UN demilitarized zone near the Grey/Yellow border.

III FORCES

A. Blue Force

The Blue force is designated as Amphibious Task Force 6 (ATF-6) and is composed, in part, of a carrier group and a landing force. The carrier group has 2 CV, 2 CG, and 10 DLG with the following associated aircraft:

Fighters	24 F-14	24 F-18
Attack	36 A-18	
Attack (all Wx)	24 A-6	

In addition, 24 Marine F-18 are associated with the landing force.

B. Orange Force

Orange aircraft available are located in the countries of Orange and yellow. At Orange airfield there are 24 Badger A, 24 Badger B, and 72 MIG-21. In Yellow there are 48 SU-7 and 72 MIG-21. Two Orange mechanized divisions complete with air support have occupied Grey near Greyport. This force is composed of:

2 Infantry divisions (20,000 men)

1 Tank regiment (420 tanks and trucks)

1 AAA/SAM regiment (6 Batteries, SA-2)

1 Artillery brigade

1 Reconnaissance regiment.

In addition there is the threat of a Red guided missile cruiser in the area.

IV BLUE CONCEPT OF OPERATIONS

The Blue concept of operations is as follows:

- CAS strikes will start after preassault strikes are completed on D day.*
- CAS strikes will be composed of A-18 aircraft as follows:

  4 on air loiter over FEBA during daylight

  4 on deck alert, constantly.
- Armed reconnaissance (ARREC) and interdiction strikes will cover Yellow roads every 6 hours; A-6's assigned.
- A high-intensity Combat Air Patrol (CAP) will be stationed over the Blue Task Force

  2 F-14 at airborne stations during daylight

  8 F-14 deck alert, constantly.
- The F-18 will maintain air superiority (ARSUP) over Grey territory.

  4 F-18 at airborne stations, constantly.
- The Marine VF squadron at Greyport will maintain 2 F-18 on CAP Over the FEBA (TARCAP) constantly, plus 8 F-18 on deck alert.
- A Surface CAP (SUCAP) composed of 1 A-18 and 1 A-6 will maintain daylight airborne surveillance around the Task Force.

---

*It is assumed that as a result of Blue preassault strikes, Orange aircraft have been withdrawn from Greyport airfield to grass fields on the Yellow border and then reinforced from Orange homeland.

V METHOD OF APPROACH

For the sake of simplification the events of the CAS problem are repeated each day. Actual events would probably be changed frequently. This can be done in more advanced problems, but calculations are complicated. Each event is handled in a game fashion--i.e., one side attacks, the other defends, and vice versa. Figure D-1 shows a picture of the events as they happen for D-day and the several days after D-day until one or the other of the air forces is expended. The basis for the losses arrived at in the following text follows from the associated aircraft capabilities, exchange ratios, and performance, and will not be repeated here.

A. D-Day Events

The following is the sequence of D-day events:

0600 Blue emphibious landings start

0600 Blue CAP and TARCAPS launched

0730 Orange aircraft from Yellow attack landing boats and Blue FEBA with 24 MIG 21 and 12 SU-7 (RAID A)

Blue defends with 2 F-18 TARCAP and 10 F-18 DLI TARCAP from Greyport

Results

Red Loss	Blue Loss
8 SU-7	12 F-18
20 MIG-21	

1030 Orange raids Blue TF

12 Badger A, 6 Badger ECM from Orange and 24 MIG 21 from ONRODA (escort) attack the Blue task force.

Blue defends with 2 F-14 CAP and 8 F-14 DLI.

ECM Badgers prevented Blue VF from full exchange ratio. 50% of F-14 effectiveness is assumed.

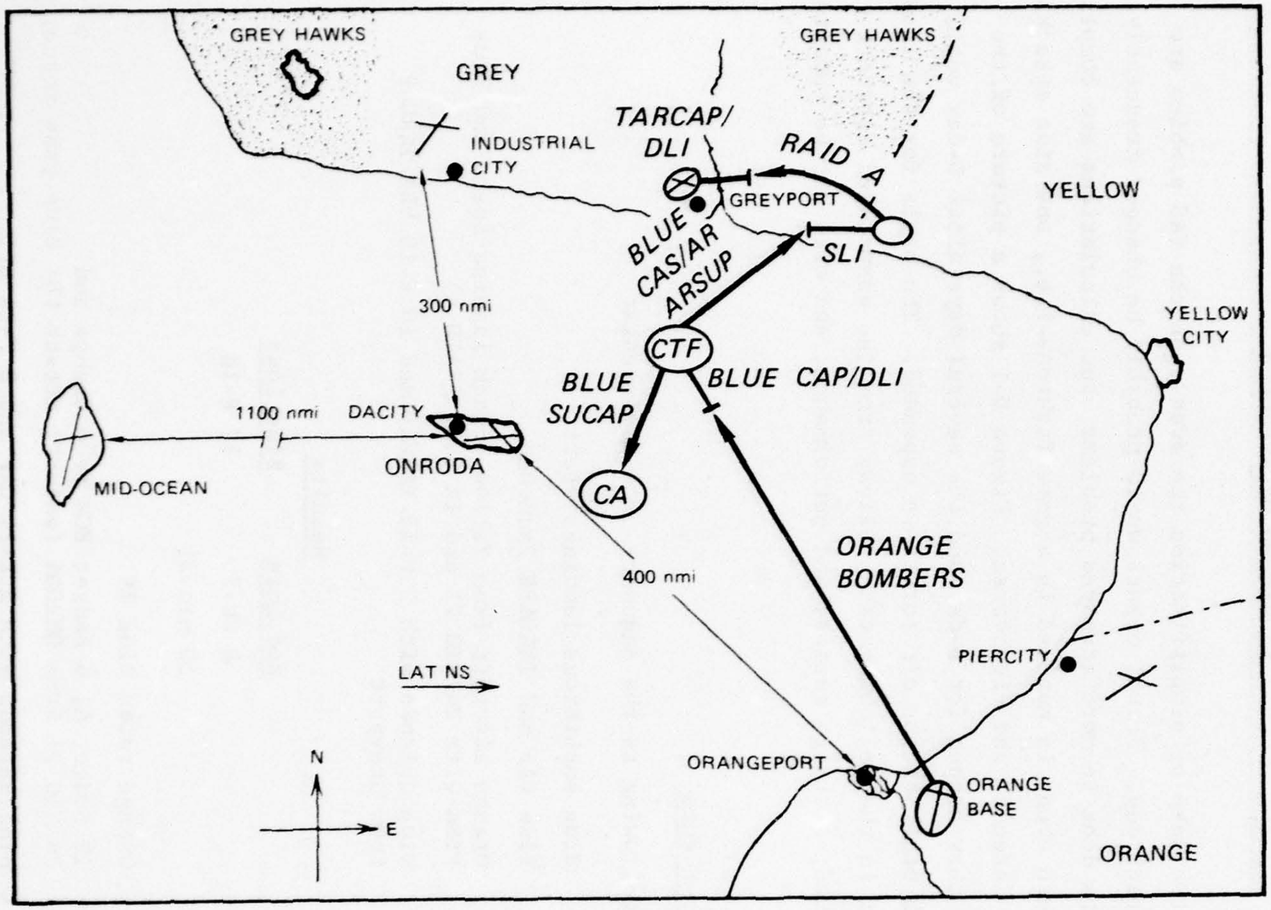

FIGURE D-1 AREA MAP AND EVENTS OF CAS PROBLEM

Results

Red Loss	Blue Loss
10 MIG 21	5 F-14
10 Badgers	

1400 Orange raids previously described at 0730 and 1030 are repeated with similar results.

0600-1800 Blue CAS and ARREC Raids.

Forty A-18 CAS sorties and 24 A-6 ARREC sorties during D-day are each loaded with Rockeye or Laser Guided bombs. Targets for the above missions are the 420 tanks and trucks of the Orange motorized regiments. The results are 76 tanks and trucks killed, and damage to two Blue aircraft.

0600-1800 Blue ARSUP raids.

Blue Air Superiority forces versus Orange SLI defenders from Yellow airfields operated during D-day on the following schedule:

> 4 F-18 on 6 cycles during daylight; 24 sorties on each cycle; 4 F-18 engage 6 SLI (MIG-21).

Cycle Results

Red Loss	Blue Loss
5 MIG-21	2.5 F-18

B. D-Day Summary

The following is a summary of D-day losses for both sides:

- Red Losses

Orange		Yellow	
Badgers	20	MIG-21	40
MIG-21	20	SU-7	16

- Red Aircraft Remaining

Orange		Yellow	
Badgers	28	MIG 21	2
MIG-21	52	SU-7	32

• Blue Losses

CTF		Greyport	
F-14	10	F-18	24
F-18	15		
A-18	1		
A-6	1		

• Blue Aircraft Remaining

CTF		Greyport	
F-14	14	F-18	0
F-18	9		
A-18	35		
A-6	23		

C. D+1 Day Events

The following is the sequence of D+1 day events:

0730 24 SU-7 from Yellow attack the Blue FEBA. Blue defends with 6 F-18 on the Air Superiority Mission.

12 Badgers and 24 MIG-21 from Orange attack the Blue task force. Blue defends with 10 F-14 on CAP/DLI.

1400 12 Badgers and 24 MIG-21 from Orange attack the Blue task force. Blue defends with 9 F-14 on CAP/DLI.

0600-1800 Blue CAS and ARREC missions continue.

D. D+1 Day Summary

The following is a summary of D+1 day losses for both sides:

• Red Losses

Orange		Yellow	
Badgers	20	MIG-21	0
MIG-21	20	SU-7	24

• Red Aircraft Remaining

Orange		Yellow	
Badgers	8	MIG-21	2
MIG-21	32	SU-7	8

- Blue Losses

CTF		Greyport	
F-14	10	F-18	0
F-18	6		
A-18	1		
A-6	1		

- Blue Aircraft Remaining

CTF		Greyport	
F-14	4	F-18	0
F-18	3		
A-18	34		
A-6	22		

E. Battle Summary

The following table is a summary of losses and original assets for the entire battle.

Blue					
	A-18	A-6	F-18	F-14	Ships
CTF	2/36*	2/24	21/24	20/24	0/26
Greyport (FEBA)			24/24		

Red				
	Badgers	SU-7	MIG-21	Tanks/Trucks
Orange	40/48		20/72	
Yellow		40/48	70/72	152/420

*(losses/original assets).

Appendix E

CLOSE AIR SUPPORT STRIKE PLAN
SOC ADAPTATION

TABLE NUMBER 1

BLUE FORCE ELEMENTS			RED FORCE ELEMENTS		
ELEMENT	EXAMPLE	CLASS	ELEMENT	EXAMPLE	CLASS
ATTACK	A18	OA	BOMBER-LO	BADGER A	OA
AW-ATTACK	A-6E	OA	BOMBER-HI	BADGER B	OA
VF-LO	F18	DA	VBF	SU-7B	OA
VF-HI	F-14A	DA	VFI	MIG-21	DA
CV	KITTY HAWK	OS	SSM-SHIP	SS-N-3	OS
SUPPORT SHIP	DLG LEAHY	DS	AIRBASE	ONRODA	OS
			SAM SITE	SAM-3	DS
			SUPPLY LINE	AAA	LS

OA-OFFENSIVE AIR
DA-DEFENSIVE AIR
OS-OFFENSIVE SURFACE
DS-DEFENSIVE SURFACE
LS-LOGISTICS SUPPORT

TABLE NUMBER 2

BLUE FORCE UNITS

B FRC UNIT		ELEMENTS PER UNIT					UNIT CHARACTERISTICS					
TYPE	SUB	VA	AW	VF LO	VF HI	SUP A/C	MAX RANGE	RANGE DEF -SUB-	WORST WX	WX DEF -SUB-	MAX DET (NM)	SPEED (MACH)
CAS -	A	2					LONG		GOOD		100	.9
ARREC-	A		2				LONG		BAD		100	.9
-												
-												
SUCAP-		1	1				LONG		BAD		100	.9
ARSUP-				1			LONG		BAD		100	.9
DLI -	A				1		SHORT		BAD		100	2.2
DLI -	T			1			SHORT		BAD		100	2.2
VFCAP-	A				1		SHORT		BAD		100	2.2
VFCAP-	T			1			SHORT		BAD		100	2.2
-												
-												
-												
-												
-												

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TABLE NUMBER 3

RED FORCE UNITS

R FRC UNIT		ELEMENTS PER UNIT					UNIT CHARACTERISTICS					
TYPE	SUB	BR LO	BR HI	VBF	VFI	SSM SHP	MAX RANGE	RANGE DEF -SUB-	WORST WX	WX DEF -SUB-	MAX DET (NM)	SPEED (MACH)
FREE -	A	2	2		4		LONG		GOOD		300	.9
RAID -	A			2	4		SHORT		GOOD		300	.9
-												
SSM -						1	SHORT		GOOD		200	.9
SLI -						1	SHORT		BAD			1.5
-												
-												
-												
-												
-												
-												
-												
-												
-												
-												

TABLE NUMBER 4

ENGAGEMENT STATISTICS FOR BLUE ATTACKING RED

BLUE FORCE UNIT		BLUE UNITS LOST PER RED DEF ELEMENT				MAX RED AIR LOST PER BLUE UNIT		RED SURFACE ELEMENTS LOST PER BLUE UNIT				
TYPE	SUB	VBF	VFI	SAM	SPLY LINE	VBF	VFI	PKED A/C	SSM SHIP	AIR BASE	SAM	SPLY LINE
CAS -	A	.25	.37	.004		2	1.3					1.1
ARREC -	A	.25	.37	.004		2	1.3					1.33
SUCAP -		.50	.75	.006		2	1.3		.6			
ARSUP -		.25	.50	.002		4	2					
-												
-												
-												
-												
-												
-												
-												
-												
-												
-												
-												

TABLE NUMBER 5

ENGAGEMENT STATISTICS FOR RED ATTACKING BLUE

RED FORCE UNIT		RED UNITS LOST PER BLUE DEF ELEMENT				MAX BLUE AIR LOST PER RED UNIT		BLUE SURFACE ELEMENTS LOST PER RED UNIT		
TYPE	SUB	VF LO	VF HI	CV	SUP SHIP	VF LO	VF HI	PARKED A/C	CV	SUPPORT SHIPS
FREE -	A	.33	.5		.12	4	2		.2	.5
RAID -	A	.50	.66	.12	.33	2.4	1.3	.2		
-										
SSM -		.19	.37	.19	.28				.2	.2
-										
-										
-										
-										
-										
-										
-										
-										
-										
-										
-										

TABLE NUMBER 6

WEAPON PLATFORM AVAILABILITY

FORCE ELEMENT	NORMAL SR	SURGE SR	R/R TIME
VA	1	2	1
AW	1	2	1
VF LO	1	2	1
VF HI	1	2	1
BR LO	1	1.5	1
BR HI	1	2	1
VBF	1	2	1
VFI	1	2	1
SSMSHIP	1	2	4

TABLE NUMBER 7

CAPABILITIES OF A/C RELATED ELEMENTS				
DAMAGE LEVEL	MAX OPERATIONS PER PERIOD --BLUE-- CV	MAX OPERATIONS PER PERIOD --RED-- AIRBASE	MAX DMGE REPAIR PER PERIOD --BLUE-- CV	MAX DMGE REPAIR PER PERIOD --RED-- AIRBASE
0.0	250	300	0	0
0.1	225	260	.07	.07
0.2	200	230	.12	.12
0.3	125	200	.15	.15
0.4	100	175	.16	.16
0.5	75	150	.15	.15
0.6	24	24	.12	.12
0.7	24	24	.07	.07
0.8	0	0	0	0
0.9	0	0	0	0
1.0	0	0	0	0

TABLE NUMBER 8

BLUE FORCE COMPLEXES

	ELEMENTS						CHARACTERISTICS					
BLUE COMPLEX	VA	AW	VF LO	VF HI	CV	SUP SHIPS	DLT LNCH TIME (MIN)	SURV RANGE FACT	FRACT A/C SHELT	CYCL TIME DAYS	REPL TIME DAYS	REPL DPS
CTFRC -	36	24	24	24	2	12	.5	1	.3	4	1	50
FEBA -			24		1		.5	1	.3	4	1	50
-												
-												
-												
-												
-												
-												

IF ADDITION, DELETION OR ANY OTHER CHANGE IS MADE TO BLUE COMPLEX NAMES, YOU MUST REVISE RELATIVE COMPLEX POSITION TABLE(13). ALL POSITIONS ARE NOW ASSUMED TO BE LONG .

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TABLE NUMBER 9

RED FORCE COMPLEXES

RED COMPLEX	ELEMENTS: BR LO	BR HI	VBF	VFT	SSM SHP	AIR BSE	SAM STE	SLY LNE	CHARACTERISTICS: DLI LNCH TIME (MIN)	SURV RANGE FACT	FRACT A/C SHELT	CYCL TIME DAYS	REPL TIME DAYS	REPL OPS
SUPL -			48	72		1	1	420	.5	1	0	6	2	50
ORGAF -	24	24		72		1	1	0	.5	1	.3	6	1	50
REDCA -					1					1	0	4	1	
-														
-														
-														
-														
-														

IF ADDITION, DELETION OR ANY OTHER CHANGE IS MADE TO RED COMPLEX NAMES, YOU MUST REVISE RELATIVE COMPLEX POSITION TABLE(13). ALL POSITIONS ARE NOW ASSUMED TO BE LONG .

TABLE NUMBER 10

MISCELLANEOUS INPUTS	
MAXIMUM NUMBER OF DAYS THE BATTLE IS TO RUN(LESS THAN 11)	10
MISSION TIME FOR LONG RANGE MISSIONS(NO. OF 3HR TIME STEPS)	0
MISSION TIME FOR SHORT RANGE MISSIONS(NO. OF 3HR TIME STEPS)	0
NO.OF OPERATIONS PER AIRCRAFT LANDING	2
NO.OF OPERATIONS PER AIRCRAFT LAUNCH	1
FRACTION OF MAX UNIT DETECTION RANGE REALIZED IN BAD WEATHER	.5
DELAY IN MINUTES BEFORE FIRST SLI/DLI CAN BE LAUNCHED	3
DO YOU WANT LONG RANGE FORCE UNIT DEFAULT IN EFFECT(1=YES,0=NO)	1
DO YOU WANT BAD WEATHER FORCE UNIT DEFAULT IN EFFECT(1=YES,0=NO)	1
STOP BTLE WHEN ALL MISSIONS COMPLETE(ELSE OFFENSE ONLY)(1=Y,0=N)	0

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EVOLUTION AND PRELIMINARY TESTS OF THE STRIKE OUTCOME CALCULATO--ETC(U)
OCT 78 R S GARNERO, J V ROWNEY, J KETCHEL N00014-75-C-0742

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TABLE NUMBER 11

BLUE OPERATIONS PLANS

MISSION	P	ORIGIN COMPLX	TARGET COMPLX	START	STOP	MISSION TIMES	UNIT TYPE	SUB	DES UNT	MIN UNT	RDY UNT
-CAS1 -	2	CTFRC	SUPL	DAY1	DLS90	1234	CAS	A	3	2	
-CAS2 -	2	CTFRC	SUPL	DAY1	DLS90	63	CAS	A	4	1	
-ARREC-	2	CTFRC	SUPL	DAY1	DLS90	12345678	ARREC	A	1.5	1	
-CAP1 -	1	CTFRC	ORGAF	DAY1	DOA90	12345678	VFCAP	A	2	1	
-DLT1 -	1	CTFRC	ORGAF	DAY1	DOA90	13	DLI	A	8	1	
-SUCAP-	1	CTFRC	REDCA	DAY1	DOS90	1234	SUCAP		1	1	
-TCAP -	1	FEBA	SUPL	DAY1	DOA90	12345678	VFCAP	T	2	1	
-TDLI -	1	FEBA	SUPL	DAY1	DOA90	13	DLI	T	8	1	
-ARSUP-	1	CTFRC	SUPL	DAY1	DDA90	12345678	ARSUP		4	1	
- -											
- -											
- -											
- -											
- -											
- -											
- -											
- -											

TABLE NUMBER 12

RED OPERATIONS PLANS

MISSION	P	ORIGIN COMPLX	TARGET COMPLX	START	STOP	MISSION TIMES	UNIT TYPE	SUB	DES UNT	MIN UNT	RDY UNT
-FREE -	2	ORGAF	CTFRC	DAY1	DOS50	13	FREE	A	6	1	
-RAID1-	2	SUPL	FEBA	DAY1	DDA90	13	RAID	A	6	1	
- -											
-SSMHT-	1	REDCA	CTFRC	DAY2	DOS50	13	SSM		2	1	
-SLI -	1	SUPL		DAY1		12345678	SLI		4	1	
- -											
- -											
- -											
- -											
- -											
- -											
- -											
- -											
- -											
- -											
- -											
- -											

TABLE NUMBER 13

RELATIVE COMPLEX POSITIONS

\BLUE / RED \	CTPAC	FEBA							
SUPL	SHORT	SHORT							
ORGAF	LONG	LONG							
REDCA	SHORT	LONG							

TABLE NUMBER 14

INITIATING WX DAYS

DAY	1									
WX	GOOD									

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TABLE NUMBER 15

CAS/ARREC — BLUE MISSION ACCOMPLISHMENT RESULTS — DAYS= 9

MISSION	P	ORIGIN COMPLX	TARGET COMPLX	START	STOP	MISSION TIMES	UNIT TYPE	UNIT SUB	DES UNT	UNT REQ	UNT ENG
CAS1	2	CTFRC	SUPL	DAY 1	DAY 9	1234	CAS	A	3	108	108
CAS2	2	CTFRC	SUPL	DAY 1	DAY 9	68	CAS	A	4	72	72
ARREC	2	CTFRC	SUPL	DAY 1	DAY 9	12345678	ARREC	A	2	144	144
CAP1	1	CTFRC	ORGAF	DAY 1	DAY 1	12345678	VFCAP	A	2	16	8
DLI1	1	CTFRC	ORGAF	DAY 1	DAY 1	13	DLI	A	8	16	16
SUCAP	1	CTFRC	REDCA	DAY 1	DOS 90	1234	SUCAP		1	36	36
TCAP	1	FEBA	SUPL	DAY 1	DOA 90	12345678	VFCAP	T	2	144	56
TDLI	1	FEBA	SUPL	DAY 1	DOA 90	13	DLI	T	8	144	24
ARSUP	1	CTFRC	SUPL	DAY 1	DAY 1	12345678	ARSUP		4	32	32

TABLE NUMBER 16

CAS/ARREC — RED MISSION ACCOMPLISHMENT RESULTS — DAYS= 9

MISSION	P	ORIGIN COMPLX	TARGET COMPLX	START	STOP	MISSION TIMES	UNIT TYPE	UNIT SUB	DES UNT	UNT REQ	UNT ENG
FREE	2	ORGAF	CTFRC	DAY 1	DOS 50	13	FREE	A	6	108	12
RAID1	2	SUPL	FEBA	DAY 1	DDA 90	13	RAID	A	6	108	12
SSMHT	1	REDCA	CTFRC	DAY 2	DOS 50	13	SSM		2	32	1
SLI	1	SUPL		DAY 1		12345678	SLI		4	288	31

TABLE NUMBER 17

CAS/ARREC BLUE CMPLX BATTLE ATTRITION RES. DAYS= 9						
BLUE	ELEMENTS ATTRITED / TOTAL ELEMENTS AT COMPLEX					
COMPLEX	VA	AW	VF LO	VF HI	CV	SUPSHIP
CTFRC	6.	1.	12.	20.	0.0	0.0
	36.	24.	24.	24.	2.0	12.0
FEBA	0.	0.	20.	0.	0.0	0.0
	0.	0.	24.	0.	1.0	0.0

TABLE NUMBER 18

CAS/ARREC RED COMPLEX BATTLE ATTRITION RESULTS DAYS= 9								
RED	ELEMENTS ATTRITED / TOTAL ELEMENTS AT COMPLEX							
COMPLEX	BR LO	BR HI	VRF	VFI	SUPSHIP	AIRBASE	SAM	SUPLINE
SUPL	0.	0.	20.	72.	0.0	0.0	0.0	386.1
	0.	0.	48.	72.	0.0	1.0	1.0	420.0
ORGAF	24.	24.	0.	48.	0.0	0.0	0.0	0.0
	24.	24.	0.	72.	0.0	1.0	1.0	0.0
REDCA	0.	0.	0.	0.	0.6	0.0	0.0	0.0
	0.	0.	0.	0.	1.0	0.0	0.0	0.0

TABLE NUMBER 19

CAS/ARREC AIRCRAFT EXPENDITURE SUMMARY DAYS= 9

DAY	BLUE VA CUM SORTIES	BLUE VA CUM LOSS TO A-A	BLUE VA CUM LOSS TO G-A	BLUE VA CUM LOSS TO A-G	BLUE AW CUM SORTIES	BLUE AW CUM LOSS TO A-A	BLUE AW CUM LOSS TO G-A	BLUE AW CUM LOSS TO A-G	BLUE VF-LO CUM SORTIES	BLUE VF-LO CUM LOSS TO A-A	BLUE VF-LO CUM LOSS TO G-A	BLUE VF-LO CUM LOSS TO A-G	BLUE VF-HI CUM SORTIES	BLUE VF-HI CUM LOSS TO A-A	BLUE VF-HI CUM LOSS TO G-A	BLUE VF-HI CUM LOSS TO A-G	CUM RED LOSSES OA	CUM RED LOSSES DA
1	44	0	0	0	36	0	0	0	56	32	0	0	24	20	0	0	68	112
2	88	5	0	0	72	0	0	0	63	32	0	0	24	20	0	0	68	119
3	132	5	0	0	108	0	0	0	70	32	0	0	24	20	0	0	68	119
4	176	5	0	0	144	0	0	0	77	32	0	0	24	20	0	0	68	119
5	220	5	0	0	180	0	0	0	84	32	0	0	24	20	0	0	68	119
6	264	5	0	0	216	0	0	0	91	32	0	0	24	20	0	0	68	119
7	308	5	0	0	252	0	0	0	98	32	0	0	24	20	0	0	68	119
8	352	5	0	0	288	0	0	0	105	32	0	0	24	20	0	0	68	119
9	396	5	0	0	324	0	0	0	112	32	0	0	24	20	0	0	68	119

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